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TECHNOLOGY ASSESSMENT OF FUTURE INTERCITY PASSENGER TRANSPORTATION SYSTEMS

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Volume 2

Identification of Issues Affecting Intercity Transportation

I. INTRODUCTION

This volume is a collection of papers on major issues and trends that will affect the future of intercity transportation. The papers were prepared by individuals representing a diverse array of backgrounds, opinions, and recognized expertise, in an effort to assemble a rich collection of discussion material.

Each reader will surely disagree with some of the ideas presented, just as in some cases, there is disagreement among the papers themselves. That there should be such disagreement is, in fact, desirable. Open, well-informed debate among concerned individuals is an important influence for guiding the evolution of the U.S. intercity transportation system in a productive direction.

While the papers in this report deal with a large and diverse set of considerations, the papers can be categorized as fulfilling one or another of the major objectives for this portion of the Study.

Some of the papers describe important political, social, technological, institutional, and economic mechanisms, the workings of which determine how future intercity transportation technologies will evolve and be put into service. These papers were prepared by acknowledged experts in a number of fields and provide essential background issues, facts, and established points of view that must not be ignored in debating the future of intercity transportation. Papers (by chapter number) that fall into this category are:

II.	Current and Future Forms of Intercity Passenger Transportation, Rail, Air, and Highway (Bus and Automobile)
III.	Constraints to the Implementation of Intercity Transportation Innovations
IV.	The Congressional Politics of Transportation Expenditure: Implications for the Future
V.	Macroeconomic Issues Through the Year 2000
VI.	Financial Issues Impacting Intercity Transportation
IX.	Issues in Regulation of Intercity Transportation
XII.	Resource Availability Inputs to Intercity Transportation to the Year 2000: With Special Reference to Energy Resources

XIII. The Future of Concern for the Environment

XIV. Social Impacts on Intercity Transportation

XV. The Transportation/Communications Trade-Off

XVI. A Note on Technology Pessimism

Another group of papers approaches the major issues of intercity transportation from the point of view of reform. While often explaining the mechanisms of the system, sometimes critically, the main thrust of these authors is that various improvements are in order, and specific options for improvement are presented. A number of the options discussed in the papers of this category are candidate transportation technologies. Such technology-related papers are included in this volume, rather than in Volume 3, primarily because of their advocacy. The papers in this second category are:

XI. Organizational and Regulatory Issues

XVIII. The Auto-Industrial Era--Is It At An End?

XIX. Electric Highway Vehicles: A Way To Save Our Mobility, Air, Energy, and Fortunes

XX. Automobile Durability

XXI. Intercity Technology and Organization: A Proposal

XXIII. Energy Considerations in Goods Transportation

Finally, there is a third category of papers that may be described as technical analyses. In these papers, the authors explore some of the important trends affecting the evolution of intercity transportation technologies, in most cases tracing out the implications of these trends in as explicit a manner as possible. Papers in this third category are:

VII. The Cost-Revenue Squeeze in Highway Finance

VIII. Interactions between Capital Funds Sources and Technological Changes in Rail and Air Passenger Transport

X. The Impact of Deregulation

XVII. The Effects of Existing Capital Stocks on Technology Assessments

XXII. Trends in Freight Transportation: 1975 to 2000

It should be noted that the assignment of each paper to one category fails to capture the full contribution of certain papers. A number of the papers contain material that falls in several categories; thus, a particular paper classified as a background issue paper may well contain suggestions about reform, as well as some quantitative analysis of trends. Consequently, the classifications should be viewed as only a rough guide to the general nature of the papers.

It should also be noted that the order in which the papers appear in this volume is not random but rather is the order in which it seems this rather large amount of material can most easily be read and appreciated as a coordinated whole.* The papers are arranged to begin with the more comprehensive views of the critical issues and conclude with the more specific presentations. In addition, a group of papers on closely related subjects generally appear together.

As this set of papers was developing, it became quite evident that almost every paper, while clarifying certain issues and answering some questions, invariably raised additional questions that could not be addressed adequately in the time available. Also, the opportunity was not available for substantial synthesis, that is, to prepare papers aimed specifically at playing out and possibly resolving the identified points of disagreement. Thus, the material presented in this report should be viewed not only as a wealth of background data, but also as an unfinished excursion into many of the major issues and problems of intercity transportation, indicating topic areas for additional investigation.

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*Detailed abstracts are presented for all but one short paper (XVI) to facilitate a rapid perusal of the entire collection.

II. CURRENT AND FUTURE FORMS OF INTERCITY PASSENGER TRANSPORTATION
Rail, Air, and Highway (Bus and Automobile)

by

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ABSTRACT

This paper poses questions on issues that may affect the future development of intercity passenger transportation (ICT).

Transportation systems divide generally into two forms: continuous movement (e.g., the endless belt) and batch movement (e.g., all ICT, including cars, buses, trains, and planes). There are two forms for ICT technologies: small-batch, vehicle switching (automobiles) and large-batch, passenger switching (buses, trains, and planes). These two technology forms suggest a twofold analysis of technological change: between systems providing a form of service, and between forms of service.

Three major paths exist for the introduction of technology: vehicle supplies, guideway and terminal suppliers, and system operators. Opportunities for technological change exist in the collector, line-haul, distribution, and switching systems.

The automobile, highway, and driver elements of the highway system have been managed somewhat independently. Vehicle suppliers consider technological change with the characteristics of drivers and guideways as given; guideway producers provide guideways based upon vehicle and operator characteristics; and drivers are licensed and governed by driving rules on usage of the vehicles and guideways. At a given point in time, the elements of a system are more or less optimized with respect to each other, but the possibility of alternative combinations of elements being more desirable is excluded.

In the railroad system, although guideways, terminals, and operations are contained in the same institution, technological change is very constrained, partly because of the historical separation of right-of-way, equipment, and operational matters, and partly because of the priority given to freight aspects of the rail business over passenger operations; regulation and unionization further limit the system's choices.

The air system has probably the most joint consideration of equipment, guideway, and operation matters of all the ICT systems.

A generalized cost function relating guideway cost per unit to the number of units moved shows continuing economies of scale. The line-haul portion of the movement achieves considerable scale economies; collection and distributor activities are more expensive. Institutional boundaries arbitrarily placed on transportation networks limit strategies that might involve network optimization; local authorities provide for access to airport, bus, and train stations; the railroads, state and federal highway authorities, and the Federal Aviation Administration generally provide line-haul routes.

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Logically flowing from the expanded capacities of line-haul routes due to technology advances and to increased system utilization is a changing investment pattern in lightly used routes. This change, including geographical route reorganizations, route abandonments, and reduced investments and maintenance, has, however, occurred only to a limited extent in rail transportation. Political pressures against service deterioration and route abandonment have served to offset pressures of changes in quantities moved and vehicle and guideway cost characteristics.

These institutional and political constraints generate inefficiencies and mismanagement in intercity transportation nets. The eastern U.S. rail crisis and the highway funding crisis are symptomatic of these matters. Rationalization of networks is needed, more so for the rail and highway systems than for the airway system.

The automobile-highway-driver system is currently the only form of vehicle switching ICT, and it offers competitive performance for trips up to about 100 miles; beyond that distance, passenger switching systems (except the bus) become competitive. One ICT issue is, then, the nature of systems (e.g., helicopters, short takeoff aircraft, and high-speed trains) that might compete in the distance range where existing systems do not perform well. Additionally, the highway system is always accessible; the air system provides only scheduled service. As for spatial competitiveness of the two modes, in most areas of the country, automobile guideway systems are ubiquitous; air service guideways are constrained within corridors.

Instances of ICT price discrimination from a spatial perspective arise. For example, two routes connect A and B (large places), one of which passes through C (small place); the price for a long haul (A to B) may be less than for a short haul (A to C). Service and price metrics are not a linear function of distance measures. Economic analysis may lead one to a contrary conclusion. Cost is a function of distance and quantity of movement. If prices charged are computed at the cost margin, prices should be low in dense (A to B) markets and high in small (A to C) markets. Actually, discrimination is against A to B travel and favors A to C travel; A to B air fares, for example, tend to be well above cost and increase too sharply with distance, with a resulting loss of efficiency.

One tension in ICT is, therefore, between economic efficiency and spatial equity of service. Even if a social reason exists for the subsidization of spatial equity, those who travel in dense markets and those institutions that provide service may claim discrimination.

Broadly, travel in a society reflects social organization. The question of passenger versus vehicle switching is one of the conformality of the alternatives with social structure. Given a taxonomy of travel types, one could match types to ICT system characteristics to test a system's social suitability. To date, no data base exists for the identification of the different ICT travel markets.

The automobile system is subject to a number of forces for change: energy and environmental considerations; safety improvements; applications of communications, computing, and control technologies; potential revision of economic evaluation procedures for the system; and an increased supply of mass transit in urban areas. Intercity car travel may take two forms: vehicles utilized because of the nature of the trip (e.g., campers) and vehicles incorporating special over-the-road technology features. Rental of vehicles could become the dominant form of usage over a period of time with rising vehicle costs.

Passenger switching systems require vehicles of higher and higher productivity to offset costs imposed by energy, environmental, safety, and labor cost factors, and this pressure is resulting in larger and larger vehicles tailoring their operations to denser markets.

Heavily trafficked corridors are and will be well served by continuing investments in existing ICT technologies, including the improvement of those supporting the upgrading of passenger rail service. Because of a lack of a national crisis or a mandate for new systems, developments are likely to grow marginally from existing systems.

Medium density corridors need alternatives such as new forms of air technology, gradual expansion of passenger rail service, and/or evolution of the highway system (including bus and auto).

Even as it tracks existing social needs, and technology delivery paths and markets, technology can be a tool which shapes social development. However, paths for ICT technological change have to be conformal with institutions as presently constituted and as altered or created in the future. Developments must be responsive to existing societal concerns and should anticipate emerging ones.

ICT properties should include two socially desirable attributes: efficiency and redistribution of goods and services. Barriers affecting the distribution of access to ICT systems include money and lack of skills (e.g., nondrivers). The larger question of access to full participation in social and economic life affects groups of diverse economic backgrounds, skills, and geographic locations. Regional economic and social development are needed to permit access to those activities that travel makes possible.

Clearly, ICT technology must take many forms to meet the needs of different markets, environments, and regional goals. Incrementalism and flexibility are important properties of ICT development options in order to respond to evolution of social goals. Short-term benefits should be highly valued, and short-term disbenefits should be heavily weighted. Development benefits must be distributed geographically by income and class.

The automobile, a general-purpose adaptable vehicle, is undergoing changes due to pressures to reduce its environmental damage and energy consumption.

Two major trends are the small lightweight vehicle and the over-the-road vehicle. Automobile rental is an alternative to ownership. Full automation of freeways and vehicles is a possibility. System accessibility could be ameliorated by licensing procedures tailored to particular vehicles, environments, and individuals; for example, subteenagers might be licensed to drive lightweight vehicles on local access roads only. The guideway system could be modified to provide a form of dual mode; properly equipped chassis could be rented for transport of lightweight vehicles and special-purpose vehicles (e.g., campers).

These developments would help to overcome the problems of geographic discrimination, pollution, energy consumption, and accessibility within the auto-highway system. Major impediments include the need for joint decision-making by driver and vehicle licensing agencies, insurance companies, and guideway and vehicle suppliers; and the need for involvement of new kinds of actors in the technology and delivery process.

The process of technology development and deployment requires imaginative actors with a sense of purpose; sponsors of research and development; the important activities of testing, production, and implementation; and, clients or markets. Current ICT systems are characterized, however, by fragmented supplies, institutions, markets, and technology and development implementation systems. No one searches for unmet needs and new opportunities. The opportunity exists for the creation of imaginative ICT technological institutions. The development of technological options should be guided by careful evaluation of the determinants of travel and of the conditions for the deployment of options.

II. CURRENT AND FUTURE FORMS OF INTERCITY PASSENGER TRANSPORTATION
Rail, Air, and Highway (Bus and Automobile)

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II. CURRENT AND FUTURE FORMS OF INTERCITY PASSENGER TRANSPORTATION
Rail, Air, and Highway (Bus and Automobile)

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Introduction

This paper poses issues that may affect the future development of intercity passenger transportation. Four intercity systems will be discussed: rail, air, bus (highway), and automobile (highway). The discussion will be morphological in style; the focus will be on the spatial forms of these systems, their services and societal needs for those services, their technology development and implementation pathways, and the forms of their constraints. The objective is to identify issues bearing on technology options for intercity transportation, and these will be identified where they emerge in the discussion.*

The first part of the paper will provide a characterization of intercity systems. Competition among the systems will then be discussed. Next, probable system developments will be considered, assuming that they adhere to their present forms during their evolution. Following this, other development paths will be considered.

Jargon. Each intercity system operates on a *net* composed of *links* serving as collector, line-haul, and distribution routes; these routes are also termed the *elements* of or the *components* of the systems.

The term *switch* will be used to describe those points on networks where travel changes from one element of a network to another.

- An interchange connecting a freeway and an arterial street is a switch.
- Airports, bus stations, and rail passenger stations are switches.

The term *mode* will be used in a nonconventional manner. Mode change occurs whenever there is a switch. A journey by automobile using local, arterial, and freeway facilities is described as a three-mode journey; a line-haul, then distributor trip by bus, a two-mode journey; taxi to the airport followed by third level air, line-haul air, and rental car, a four-mode journey.

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*Fiscal and regulatory matters are slighted because they do not emerge naturally from the approach in this paper and because they are stressed elsewhere in this series of papers.

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Rail routes, highways, and airways will be termed *guideways* when a general term is useful.

Intercity Transportation Systems

This section will provide a description of the present intercity systems and identify two types: small-batch vehicle switching and large batch passenger switching. Next, the paths for technology flows to the systems will be identified, namely, technology supplied via the vehicle, the guideway, and operations. There are many constraints on the systems, and these and other factors have led to decision-making about technologies that will be termed disjoint and biased. This material is quite general and well known, yet its presentation will require several pages; some readers may choose to skip to the next section of the paper.

The Systems. Transportation systems of all types divide generally into two major forms: continuous movement systems, such as the endless belt, and batch movement systems. Automobiles, buses, trains, and planes move passengers in batches of different sizes, and all intercity passenger transportation is batch transportation.

Switching is typically required in intercity movement. The airline passenger typically moves by highway from the point of origin to the airport, by plane from airport to airport, and by highway to the point of destination. A change of planes requires an additional switch. Similar patterns hold for rail and bus travel. Bus and rail passengers have higher probabilities than air passengers of using urban transit in the origin-destination portions of their trips because their stations or switches are located in the older sections of cities where transit service tends to be available.

Intercity automobile travel typically involves driving on local and arterial streets near the origin and destination points of journey, and on high-level facilities, usually a freeway, on the line-haul portion of the trip. An important difference between the automobile system and the other systems is that the vehicle switches from one mode of travel to another (viewing driving on arterial and local streets as different modes than freeway travel), whereas passengers switch in the other systems. The switching impedences or delays at terminals are important in rail, air, and bus travel. The issue of what should be done to reduce switching impedences in passenger switching systems is quite important.

It may be noted that opportunities for technological change may be located in the collector system, the line-haul system, the distribution system, and/or at the switches. This is a rather obvious point. It is mentioned here to remind that the *technology issues of intercity transportation are not limited to the line-haul portions of the intercity systems.* There are technology opportunities in each component of the systems. Further, effective use of a technology in one system component may require

adjustments in other components. Increased line-haul capacity would affect collector and distributor systems, for example.

All intercity passenger movement is in batches and the batches range in size from one person in an automobile to several hundred persons in an aircraft or train. All movement requires travel in different modes and some form of switching. A simple but important matter is whether the vehicle switches or whether the traveler must switch from vehicle to vehicle, and there are two forms for the technologies: (1) small-batch, vehicle switching and (2) large-batch, passenger switching. The automobile is in one class; buses, aircraft, and trains are in another. This is hardly startling observation, for as everyone knows travel by automobile is different from travel by air, bus, or rail, and the switching of the vehicle is one important difference. Other differences include the control of the travel schedule by the traveler and the personal environment of the automobile as opposed to the public environment of the other carriers. It is in these ways that the automobile provides one form of service and the bus, train, and aircraft another. At one level of abstraction, intercity passenger transportation systems compete on the basis of cost and elapsed travel time. At another level of abstraction, they compete on a quality basis, say the degree to which the service is personal as opposed to public. To the extent that there are these quality differences, and the extent is unknown, *issues of the competition among technologies for markets and opportunities for technological change must be assessed within forms of service as well as between forms of service.*

Markets. Some markets are very sparse or light, and others are very heavy or dense. Some serve places separated by many hundreds of miles, others are closer. The quantity of travel between two places is mainly a function of their sizes and the distance between them, and there is a continuum of market sizes. In order to capture these differences in markets, three types will be recognized here for use later in the discussion: situations where there is much demand for movement such as Philadelphia-New York, or Los Angeles-Chicago; corridors where demands are not nearly so high such as Chattanooga-Atlanta; and sparse markets such as travel to and from small places. The latter includes travel to and from small places in the hinterlands of large cities.

Paths for Technology. It is useful to consider three technology introduction paths: (1) technologies incorporated in vehicles and provided by vehicle suppliers, (2) technologies provided by guideway and terminal suppliers, and (3) technologies provided by the system operators. In the systems here considered, vehicle equipment is supplied by the private sector, mainly by private sector institutions other than the institutions using the equipment. However, the railroads have historically assembled some of their freight car equipment; one major bus operator assembles buses. Equipment may be leased or owned outright by operators.

Subject to limitations on the variety available in the market, automobiles are purchased or leased by customers according to their conception of

their desires. The survival of the vehicle manufacturers depends in part on their ability to evaluate the market and meet needs of customers. The automobile has about a ten-year physical life which is shorter than that of other intercity transportation equipment, and relatively rapid changes in the technology of the automobile fleet may be imagined.

Buses, aircraft, and passenger train equipment are purchased or leased by operators, and the test of vehicle suitability to the market occurs when attempts are made to attract passengers. These vehicles typically have a longer physical life than automobiles, and they are utilized much more intensively; they deliver many, many more seat miles of travel during their lifetime than does an automobile. It is more difficult to fit these vehicles to their market than automobiles. *An issue for passenger switching systems is that of matching vehicles to markets: passenger perception of suitability may change with time; vehicles are purchased by operators rather than by the final users; and vehicles are utilized by many different persons, each of whom has a particular set of preferences.*

Equipment technology is based on mechanical engineering knowledge and on knowledge of many related fields. It is important to this discussion to note that professional groups are associated with particular vehicle types, e.g., aerospace engineers and automotive engineers, and that there is little communication among these groups and between those groups supplying technology to other aspects of the systems, e.g., the guideways.

Highway and air guideways and switches, except some bus terminals, are provided and operated by the public sector. Historically, the rail guideway and switching (terminals and yards) system has been privately owned and operated, with terminals sometimes owned and operated in some collective format.

The highway physical plant has been developed by the state departments of highways in partnership with the Bureau of Public Roads and its successor agency, the Federal Highway Administration (FHWA). These agencies have planned route alignments and capacity, and they have set standards for design and construction. Excepting pavements, the elevation and curvature, drainage facilities, structures, and so on are oriented to a life of 50 years or more. The basis of the technology is mainly civil engineering knowledge, and it is supplied by professionals in the fields of structures, soil mechanics, hydraulics, and so on, from consulting firms or employed by state highway agencies.

The spatial framework for the rail guideway system was established in the previous century. Private capital was raised (and, on occasion, public capital), and private contractors constructed facilities in accordance with specifications by railroad properties or as required by money market organizations. Over the years these specifications became more stringent, especially with respect to structures, rail and ballast, and grade and curvature. Partly as a consequence of requirements for capital repayment to large investments in physical plant, many railroads have been subjected

to financial reorganization, and currently most railroads do not have access to private capital for guideway investments. In recent years emphasis has been on maintenance of existing facilities and on selective upgrading of facilities only in instances where projects are small and pass stringent cost-effectiveness tests. However, there has been major investment in large, modern freight yards. The situation varies from railroad to railroad. In some, the cash flow has not been great enough to avoid deferring maintenance.

The course of technology for the construction of rail guideways has been similar to that for highways. It is mainly from and via professional civil engineers and has been realized in structures, drainage facilities, etc. There has been much communication and sharing of basic civil engineering knowledge between rail, airport, and highway engineers.

While automobiles are operated by individual drivers, as are buses, there is a traffic control form of operations management created and operated in part by public sector or consulting traffic engineers.

An issue arises from the separate peer groups, environments, constraints, etc., that provide the technologies that comprise a transportation system. They are quite disconnected. Rarely does an actor or institution regard itself as being in the transportation business. Many are involved, few are concerned with affairs beyond their immediate role. The automobile companies regard themselves as manufacturers of mechanical equipment; the engineer building a highway bridge regards himself as a structural engineer, he has little interest in or knowledge of the role the bridge will play.

Disjoint-Biased Decision-Making. The vehicles, guideways, and operations elements of intercity transportation systems receive technology via differing paths and with differing conditions, depending on whether or not a technology will be used and/or the level at which it will be introduced and utilized. Additionally, the systems operate under constraints that differ from system to system. Consequently, the intercity systems have evolved in response to what may be termed disjoint-biased decision-making. (Disjoint refers to the manner in which system elements have been considered, and biased refers to the differing criteria for decisions from element to element and system to system.)

The automobile, highway, and driver elements of the highway system have been managed in somewhat independent ways. The vehicle supplier considers technological change with the characteristics of drivers and guideways as given; the guideway producers (the FHWA, state highway departments, etc.) have provided guideways in light of vehicle and operator characteristics; and drivers have been licensed and subjected to driving rules developed with reference to the equipment used and the guideways upon which they drive. A similar set of remarks may be made about bus systems.

The consequence of this is a limitation on the feasible ways the system might develop. At any point in time, the elements of the system are more or less optimized in relation to each other. But the question of whether some other combinations of vehicles, guideways, and operators might be more desirable than the extant system does not enter the decision-making. An illustration may help to develop this point.

A major problem with the automobile-highway system is the lack of accessibility to that system; some one-third of persons of eligible age do not have drivers' licenses, either because they are not licensable to drive or because it is too expensive. To solve this problem, one might imagine vehicle and guideway combinations that are much less demanding of driver skills. These might utilize simplified vehicles with reductions in vehicle cost or complex and expensive vehicles which are used very intensively and thus have a lost cost per unit of use. (Personal rapid transit with low fares and requiring only that operators know where they are going and can push a button is an extreme form of a high vehicle productivity, low skill operations system.) Decisions about such systems require joint consideration of vehicles, guideways, and operations, but the traditional form of decision-making is such that joint considerations are not made.

While in the railroad system the guideways, terminals, and operations have been within the same institution, the pattern of technological change has nonetheless been very constrained. This is partly because the historical, institutional form of railroads has separated right-of-way, vehicle equipment, signals and communications, and operational matters. And it is partly because first considerations in guideway and operational matters are of the freight aspects of the railroad business. Rail passenger equipment and methods of operating passenger service have been constrained to be conformal with freight movements. (These conditions did not hold many years ago when there were markets in which passenger business was the major business.) Also, regulation and unionization matters have limited the range of choices of rail systems.

The air system has probably had more joint consideration of equipment needs, guideway characteristics, and the nature of operations than is true of other intercity transportation systems.

Technological Change Within Present Intercity Transportation Systems

This section will consider technological change in intercity transportation, in particular that change which is evolutionary and which occurs within the frameworks of existing institutions, paths for technology delivery, and technology development and implementation incentives. First, to augment the discussion in the previous section, additional characteristics of guideways and vehicles will be considered. Competition among systems will then be discussed. A discussion of likely systems evolution and associated technology closes the section.

Guideways and Guideway Utilization. As noted, a transportation system operates on a guideway net consisting of collector, line-haul, and distribution elements (Figure II-1). Important features of this net are the economies of scale associated with its more intensely used segments.

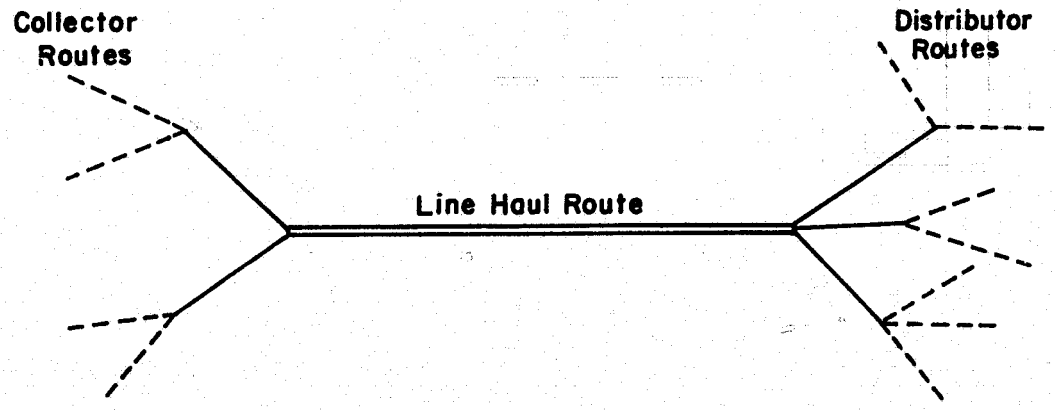


Figure II-1. THE NETWORK OF AN INTERCITY TRANSPORTATION SYSTEM

A generalized cost function relating the guideway cost per unit--say, the annual cost of a mile of freeway lane--to the number of units moved--say, cars per year--shows continuing economies of scale (Figure II-2). Line-haul movement allows considerable scale economies; collector and distribution activities are more expensive.

Consideration of network geometry and cost permit identification of some of the major issues affecting intercity transportation systems. First, *there are issues resulting from institutional boundaries arbitrarily placed on networks which limit strategies that might involve network optimization.* In the automobile-highway system, for example, the collector and distributor routes are typically local roads provided by land developers and arterials provided by cities or by cities in partnership with the states. The line-haul routes are typically state highways or part of the Interstate System, and these are provided by the states in partnership with the federal government.

Local road or transit authorities provide for access to the airport, bus, or train station; and line-haul routes are provided by railroads, the state and federal highway organization, or by the Federal Aviation Administration (FAA). Airline companies differ in the extent to which they are made up of high-use vs. low-use routes.

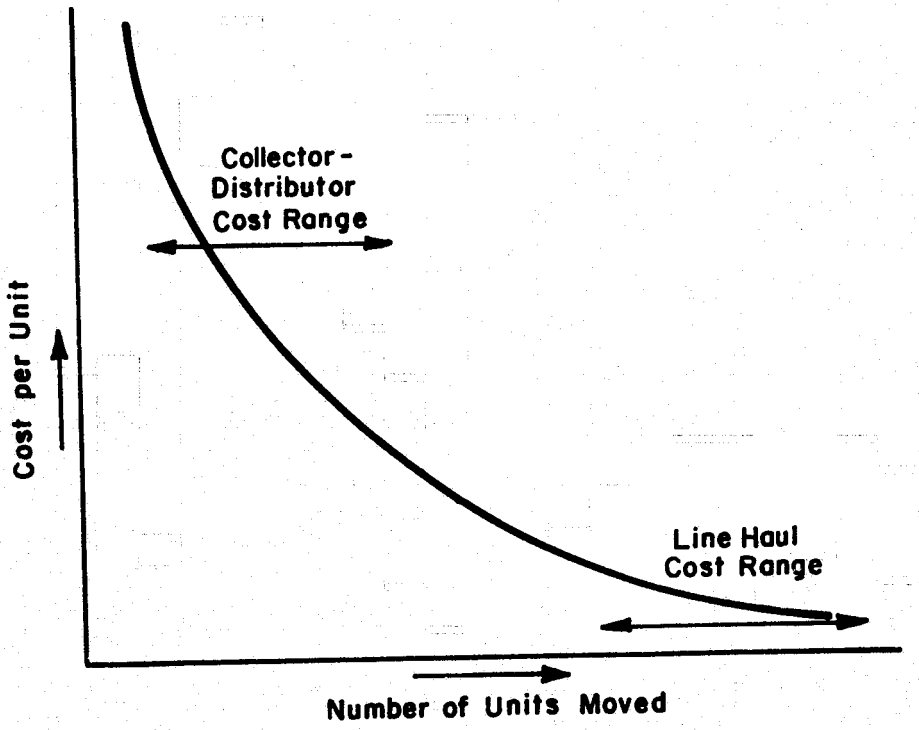


Figure II-2. GUIDEWAY COST PER UNIT OF USE

A second matter is that of the forces which have affected investment and disinvestment in routes serving different functions. The historical pattern has been that of development of low-density routes; subsequently, with advances in technology and increases in system utilization, selected routes were upgraded or built anew to handle large volumes of traffic. This generalization holds quite well for the highway and air route system, and it holds, but not as well, for the railroad system where some of the main routes were identified early on. Even so, there have been orders of magnitude improvements in the capacities of line-haul routes as technological, economic, and market forces emerged.

The logical corollary to increased capacity on line-haul routes is that of changing investment patterns in more lightly used routes. This change in investment might take the forms of geographical reorganization of the routes, abandonment in some cases, and reduced levels of investment and maintenance where appropriate. These have taken place to a limited extent in rail transportation. There has been an offsetting force, namely: political pressures against deterioration of service and route abandonment. These may be noted especially in the highway plant where the network originally designed to accommodate low-density use by horse-drawn vehicles has been continued. Changes in that system may be described as layering--the overlaying of arterial, state highway, and then interstate-type facilities on a horse and wagon net.

This is an important point, so it will be stated in different words. Early network patterns reflected the joint cost of providing the facility and using the facility. Presumably, the antecedents of the road network, e.g., trails, were based on this consideration as were the original networks of urban and rural roads and streets. The early railroads and early air nets also reflected the conditions of the time. There has been political pressure to maintain those patterns in spite of the very sharp changes that have occurred in the quantities to be moved and vehicle and guideway cost characteristics.

The consequences of these two considerations--differences in institutional structures from place to place in the net and political pressure that tends to preserve established network elements--is that to some unknown extent intercity nets are inefficient and to some unknown extent they are mismanaged. The railroad crisis in the eastern United States is a symptom of these matters as is the crisis in highway funding. To avoid continuing these problems, it seems axiomatic that *issues of new investment and new programs for intercity passenger transportation must extend to the networks within which those developments might be imbedded and to the problem of the rationalization of networks.*

The remarks above are in one sense less applicable to the airway system than to the rail and highway systems. Regarding the former, one agency, the FAA, provides the guideways, and guideway costs are by far the lesser part of the sum of guideway and vehicle operating costs. One major element of guideway cost, the number of air traffic controllers provided, is (approximately) a linear function of the number of aircraft handled. However, the pressure for airport-related navigation facilities and for the provision of physical facilities at relatively lightly utilized airports occasions higher costs on lightly used segments of this system than on more heavily used segments.

Competition in Intercity Transportation. Again, intercity transportation technologies operate in two forms, small-batch vehicle switching and large batch passenger switching. For purposes of identifying the structure of competition and factors bearing on competition, it is sufficient to deal with these two forms. For convenience, highway and air will be used as illustrative of these forms.

The automobile-highway-driver system is currently the only form of vehicle switching intercity transportation, and, as usually viewed, it offers competitive performance for trips up to about 100 miles in distance. Beyond that length, passenger switching systems, excepting the bus, become competitive. The Bouladen scheme (Figure II-3) illustrates the competitive position of the two systems. This chart suggests that the competition question is only in part that of existing systems competing in a common market. *The intercity passenger transportation issue is partly that of the nature of systems that might compete in the distance range where the existing systems do not perform well.* Helicopters, short takeoff aircraft, and high-speed trains have been suggested as technological forms

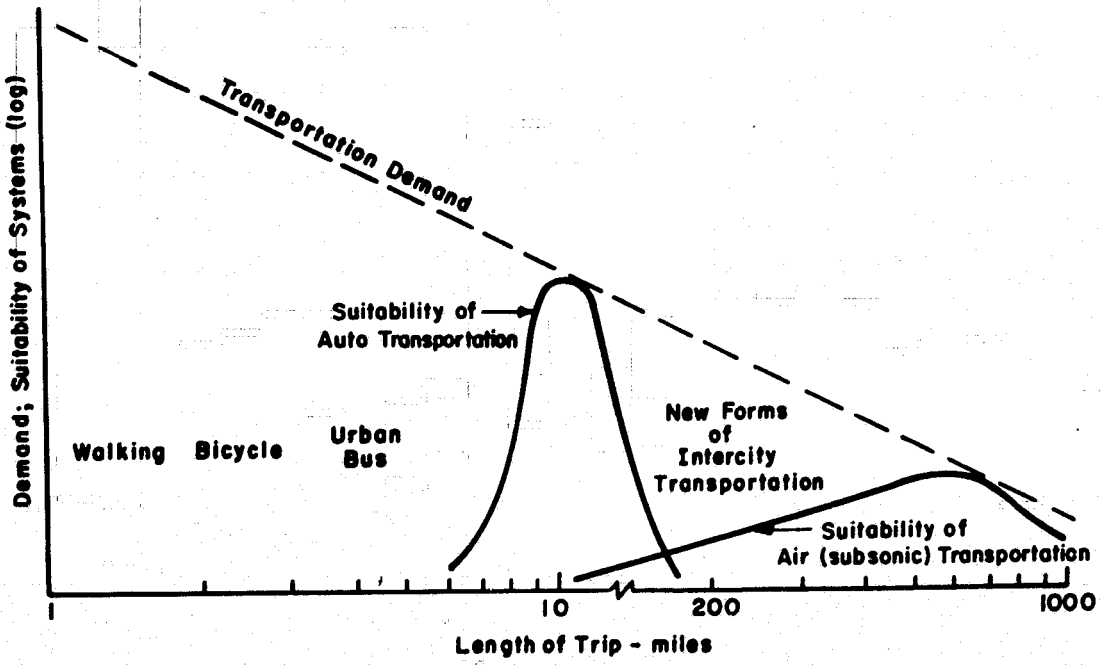


Figure II-3. SUITABILITY OF TRANSPORTATION SYSTEMS
(Adopted from Gabriel Bouladon, *Transportation Gaps*, Battelle (Geneva), 1967)

that might provide competitive service in that distance range. The competitiveness of such passenger switching systems turns in a large measure on their competitiveness against vehicle switching systems.

Because all intercity transportation is multimodal and because speeds on local facilities used for the collector-distributor modes of travel are less than those on line-haul routes, the time-distance relationship for intercity travel takes the form shown in Figure II-4.

For origins and destinations separated by approximately 100 miles or less, the automobile offers the least travel time. Beyond approximately 100 miles, the aircraft offers the least travel time.

Figure II-4 holds for a particular origin and destination and for a particular availability and density of service; at any point in time, the automobile system can offer service along the illustrated time-distance relation. The air carrier time-distance relation depends, however, upon the schedules. If the desired time of arrival at the destination fits the air schedule, then there is no schedule delay. If this is not the case, then there may be schedule delays. The magnitude of these delays depends upon the frequency of service which, in turn, is a function of service density.

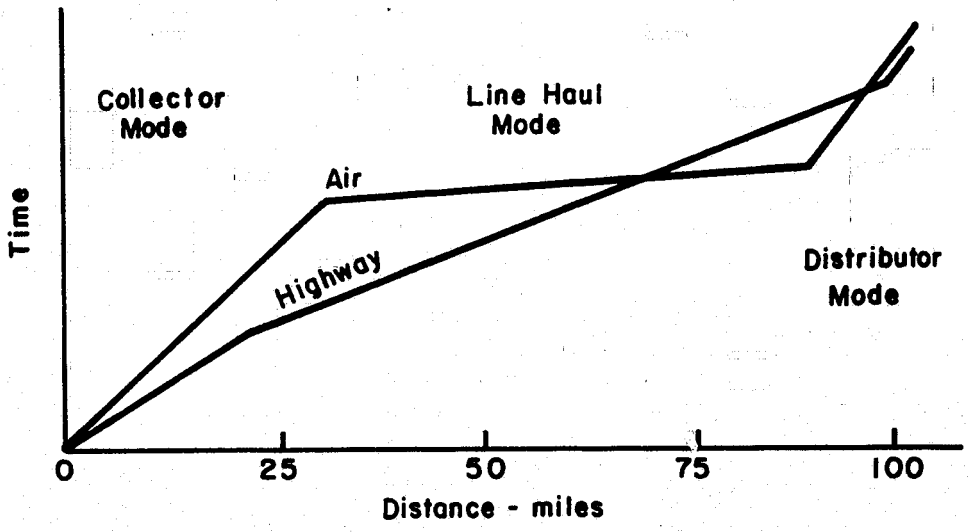


Figure II-4. TIME VERSUS DISTANCE, HIGHWAY, AND AIR

The cost from origin to destination also, of course, enters the calculation of modal choice. The situation is complex. It involves whether the cost is incurred by the individual or whether it is incurred on the part of a second party such as a business organization. It depends on more than line-haul cost. Those who are very willing to trade off time vs. money may well trade in the origin and distribution portions of their travel rather than the line-haul portions; e.g., instead of taking a taxi to the airport, take public transportation.

Regarding the automobile, the number of persons that will travel sharply affects the cost competitiveness. A family of four on a trip in an automobile trade-off cost relationships at levels (approximately) of one person in a car vs. four aircraft fares. If, however, travel involves a visit to a congested urban center, then the automobile may require storage and will be of little value or of negative value while undertaking the travel purpose. In addition to the standard automobile, there are numerous other forms of switching vehicles--campers, trailers, off-the-road vehicles, and so on. These are purchased and used for particular travel purposes, and they are highly competitive against air transportation.

In addition to differences in time competitiveness between auto and air service, there are differences in the spatial competitiveness of service. In most areas of the country, the guideway systems for automobiles are more dense than for air service. Also, the automobiles may be used along a radius extending in any direction from a city; air service is limited to particular corridors. The differences in what might be termed network scale of fineness are illustrated on Figure II-5. (The figure oversimplifies the situation somewhat: charter air service or private aviation fills in between those areas where regular service is available.)

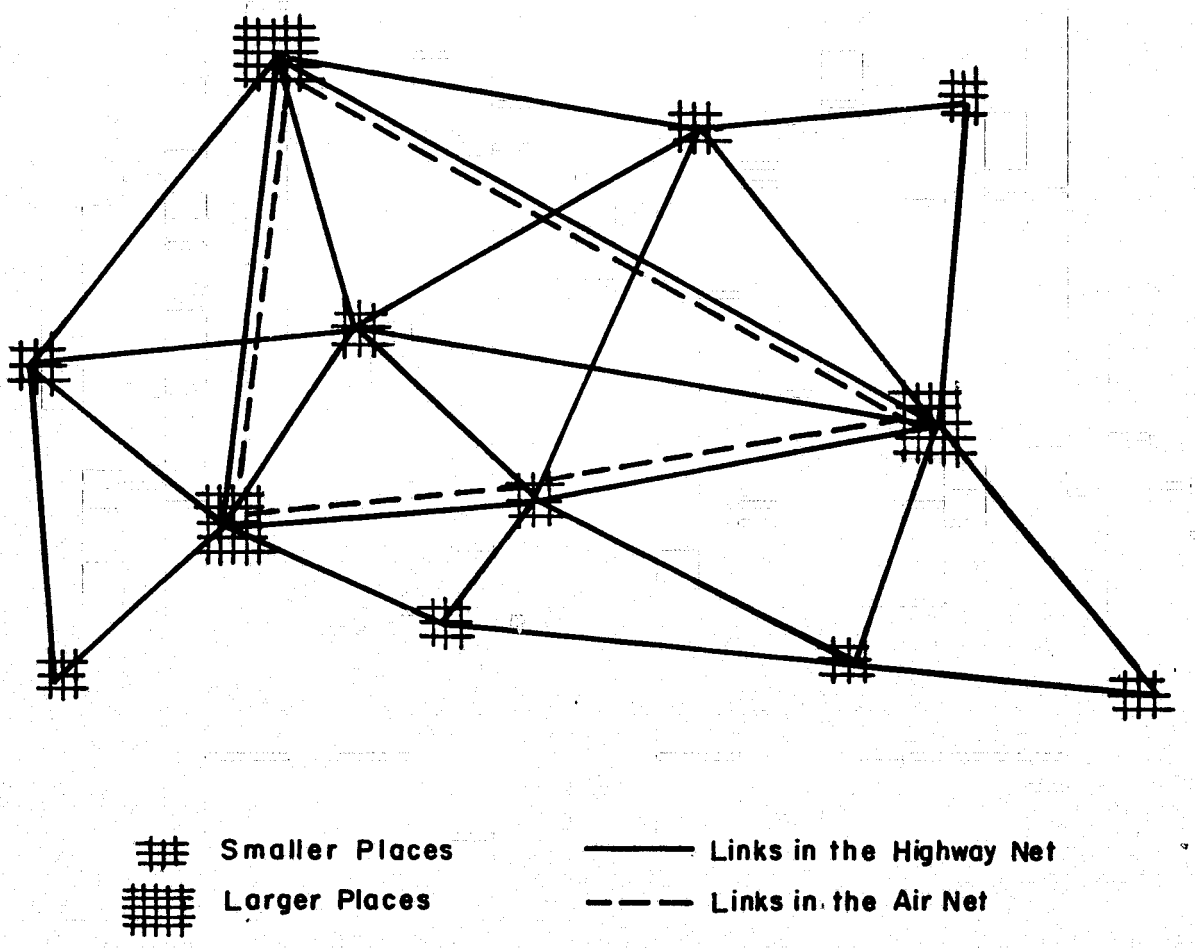


Figure II-5. THE HIGHWAY NET COMPARED TO THE AIR NET

During the last century, there were many instances of railroad price discrimination from a spatial perspective. (The ICC was created, in part, to eliminate this discrimination.) The price charged for long haul, say from A to B on Figure II-6, was in many instances less than that charged from A to C. The reason for this was the competitive A to B service which resulted in rate reductions. This type of spatial discrimination appears today in similar form but for other reasons. If A and B are large places and C is a small place, then the time to get from A to B may well be less than that to get from A to C. The cost might also be less if there is no night coach service from A to C and there is from A to B, or if the trip from A to C requires using a third level carrier. A similar set of remarks about time and costs might apply for the highway system, e.g., if A and B are linked by the Interstate, but C is not. This, then, is one form of discrimination: service and price metrics are not a linear function of distance measures. Persons living in places such as C and/or using A to C, B to C routes feel that this type of discrimination is unfair.

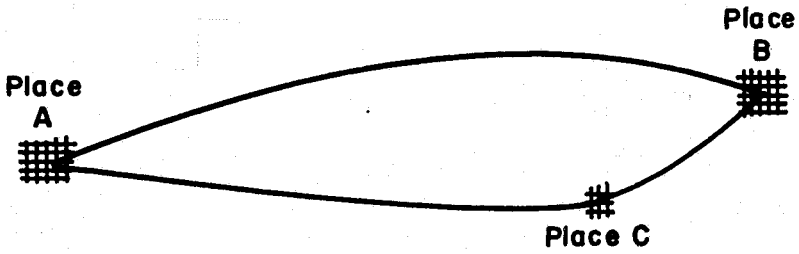


Figure II-6. TWO ROUTES CONNECT A AND B, ONE OF THESE PASSES THROUGH C

Economic arguments lead in another direction. Cost is a function of the quantity of movement and of distance, and costs are lower in dense markets than in sparse. Air transport costs are not a linear function of distance. There are terminal costs followed by costs of bringing the aircraft to cruise altitude and speed. The plane then decreases speed, which increases cost per mile, and lands and incurs terminal cost. If prices charged were computed at the cost margin, then prices would be low in dense markets and high in small markets. For city pairs separated by different cruise distances (and with similar quantities of travel) fares would be little different. There is evidence that fares are well above cost in the larger markets and that they increase too sharply with distance. Discrimination is against A to B travel and favors places such as C. Moreover, because prices are not computed at the cost margin, there is a loss of efficiency, its cost being estimated at from $1 billion to $2 billion per year. Statements similar to these may be made for auto, bus, and rail systems.

One tension is between economic efficiency and spatial equity of service. Is partial spatial equity worth several billion dollars, should more efficiency be cost in search of greater equity? Should less equity be accepted in favor of efficiency? In a $2 trillion economy, how much is spatial equity worth? There is no expert answer for these questions, they require political decisions.

Even if there is a social reason for the subsidy of equity, those who travel in dense markets and those institutions that provide service may claim discrimination. Why should they pay for some national social goal?

At issue, then, are the forms, incidence, and impacts of spatial discrimination in the provision of intercity passenger service.

A second tension involves technology. Technology development has supported increased efficiency in dense markets; it has done little for sparse markets. One reason for this is clear. The dense markets have been the viable economic markets for technology. There has also been feedback; technology successes have made the dense markets even more viable. Although there may be social reasons for service in sparse markets, the economic rewards for technology have not been great. *At issue*

is the conjecture that technology development has been biased and has served only a limited segment of needs. This conjecture will be treated at several places in the subsequent discussion.

Because of the factors affecting competition, the Bouladon scheme (Figure II-3) does not agree with the division of the market, and the automobile is utilized well beyond the 100-mile radius where its suitability according to Bouladon begins to drop sharply (Figure II-7).

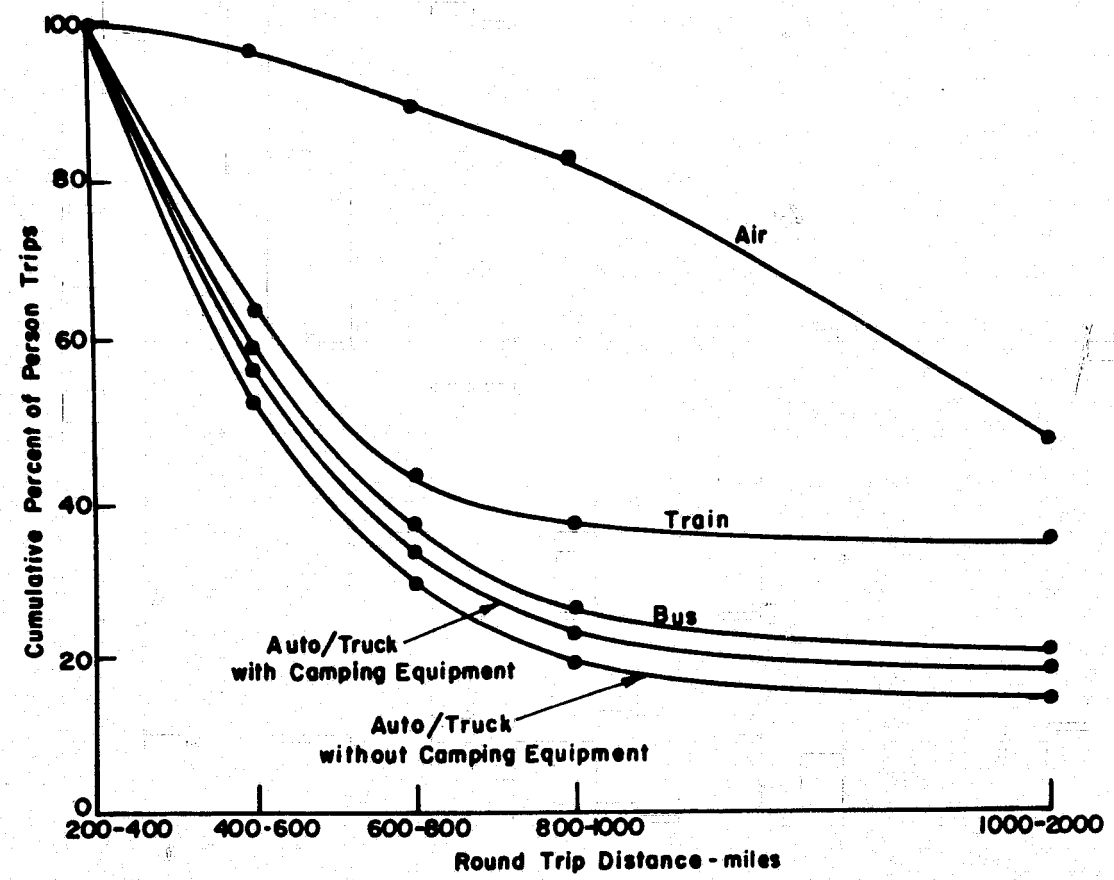


Figure II-7. DISTRIBUTION OF PERSON TRIPS BY ROUND TRIP DISTANCE

Sources: U.S. Bureau of the Census, Census of Transportation, 1972, Volume 1, *National Travel Survey*, U.S. Government Printing Office, Washington, D.C., 1973.

Strate, Harry E., Federal Highway Administration, *Nationwide Personal Transportation Study, Report No. 1: Automobile Occupancy*, U.S. Department of Transportation, Washington, D.C., April, 1972.

Ibid, Report No. 2: Annual Miles of Automobile Travel, April 1972.

The travel shown in Figure II-7 may be interpreted using a modified Bouladon scheme, as shown in Figure II-8. In addition to the one-passenger, direct time type of automobile transportation competition with air (as per Figures II-3 and II-4), other types and situations of travel appear in endless combinations. Terming Type I that travel of one person where air is an alternative for distances beyond 100 miles, some other types might be:

- Type II: two or more persons in a car for whom cost considerations are important;
- Type III: salesman, uses car to store and transport sample and display materials;
- Type IV: on trips where vehicle will be needed to fulfill trip purpose--e.g., driving a camper.

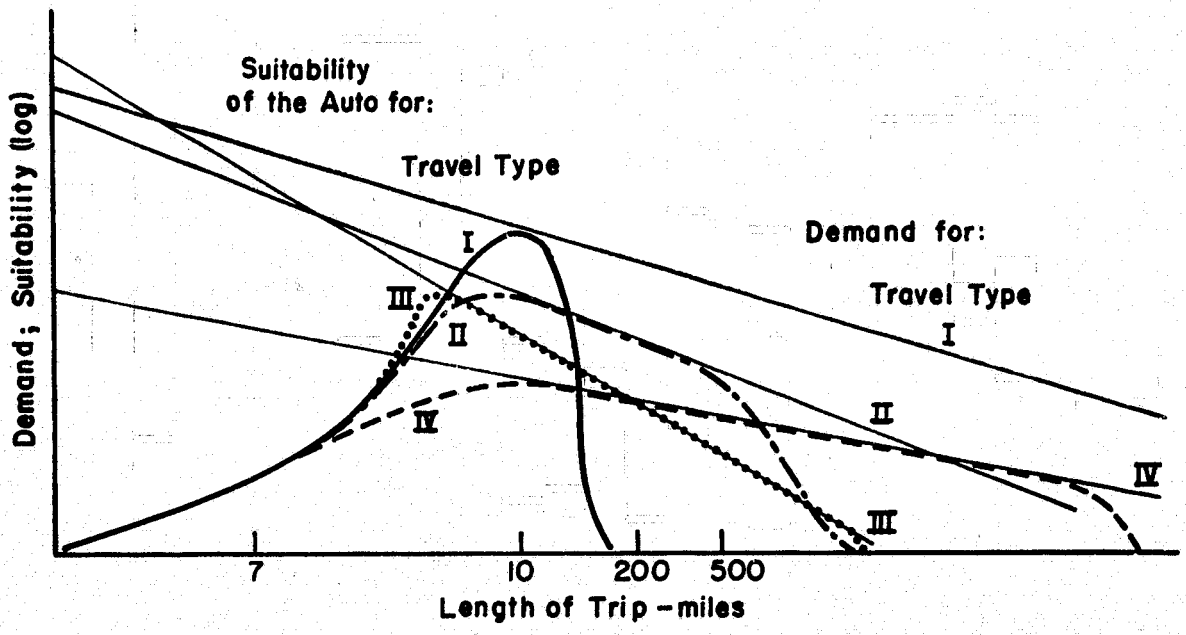


Figure II-8. SUITABILITY OF THE AUTOMOBILE FOR TYPES OF TRAVEL

Air travel could also be divided into trip types with the suitability of air travel differing for trip types. Note also that the notion of trip types and thus many market divisions is not reflected in empirical work on intercity travel, so there is no information available on relative sizes of markets. There are data on common carrier air travel between city pairs, but data of travel on other systems is very limited.

Broadly, travel is a reflection of social organization, the institutions, formal and informal, of society and the associations of people and resources with those institutions. At this level of thinking, the question of passenger switching versus vehicle switching systems is one of the conformality of each system with social structure. To the extent that a taxonomy of travel types captures the ways in which people relate to social organizations, matching travel types to system characteristics is a test of system social suitability.

The issue is that there is no suitable data base from which the social organization basis of intercity travel may be identified.

The Likely Future of Intercity Transportation. The discussion will turn now to how the intercity systems might evolve given their characteristics, their competitive situations, etc. Use of technology to increase efficiency, a classic role for technology, provides one force for change.

In the automobile transport system, efficiencies have been achieved by technologies such as freeways; but the institutions and fiscal arrangement for freeway construction no longer have the capability for extensive construction programs, and there is also resistance to extensive construction, especially in urban areas. In recent decades highway expenditures have run about 1% of the gross national product. The demands of the existing plant for maintenance and rehabilitation have increased to absorb nearly all of the funds available. Consequently, the new highway construction market for technology is of decreasing importance, and little physical expansion of the guideway system should be expected unless major institutional and funding adjustments are made.

While the cost relationships for automobiles suggest that larger and larger vehicles could be produced with small incremental costs, the automobile is an element of a personal transportation system, and the market constrains the gains to be achieved by increasing the number of seats in automobiles. The reverse is also true. From the standpoint of economies of vehicle production, there is not much to be gained by decreasing the size of vehicles (the relation between weight and energy use is another matter).

Buses gain efficiency from increased size, but increases in vehicle size are thwarted by size limits for vehicles on highways and by market considerations constraining the number of people who can be collected at a point at a given time to be moved to another point at a given time.

There are opportunities for technologies and efficiencies that might be obtained by passenger trains if these could be formed of larger cars ganged into larger trains. The market again thwarts opportunities for such technologies.

The pattern in air transportation has been that of tailoring vehicle efficiencies to route characteristics, and the opportunities have been

captured largely in dense traffic, line-haul situations. To the extent that the market permits, opportunities for related technological developments will continue.

At issue are changes resulting in intercity passenger transportation from new investment to increase efficiency. Given present conditions, the outlook for increased efficiency is modest other than in air transportation.

There are forces for change that may not increase efficiency as it is usually considered but may provide opportunities for technology. The automobile system is subject to a number of forces for change.

1. Energy and environmental considerations will likely occasion vehicle noise reductions, weight decreases, and propulsion energy efficiencies.

2. Improvements in safety are resulting in more complex vehicles and a short-run impetus toward a heavier vehicle. Increased vehicle inspection, resulting in improved maintenance and safety-motivated investments in guideways, would join with increased complexity to increase vehicle cost. More stringent drivers' licensing in the interest of safety coupled with increased insurance cost may reduce accessibility to the automobile-highway system.

3. The full impact of communications, computing, and control technologies has yet to be felt in the automobile-highway system. Most of this technology is delivered through traffic engineering and should result in improvements in traffic flow, improved safety, and improved driver knowledge about travel conditions. Some work has been done with electronic guidance systems (and with mechanical guidance systems), and this might begin to impact intercity transportation within two decades. One form might be that of a lane reserved for high-speed travel where vehicles are equipped for guidance. This would also have impacts on bus and truck movements.

4. The potential for revised economic evaluation procedures for the automobile-highway system, including new rules for investment in and use of the system, is also a pressure on the system. Because of the external costs incurred but not charged to the gas tax income, the driver may be required to pay several cents more per mile of travel. Furthermore, guideway investment is made at artificially low interest rates. Rationalization of costs would increase costs for automobile operation one-fourth to one-third over current costs. Additionally, there is interest in congestion pricing which might be implemented in urban areas. Freeing the flow of traffic would decrease travel times on the origin and destination portions of trips; it would also have the effect of making travel more expensive (to the user) during periods of congestion.

5. There are programs to increase the supply of mass transit in urban areas, which might make the automobile less competitive and might improve access to terminals.

A probable reaction to these pressures is a changing ownership pattern for automobiles, with vehicle types purchased or rented according to the particular demands to be satisfied. A current example is the purchase or rental of off-the-road and camping vehicles to meet special needs. Another probable reaction is the development of lightweight, energy efficient urban vehicles.

Intercity automobile travel might occur in two forms: in vehicles utilized because of the nature of the trip (e.g., campers), and in vehicles incorporating special over-the-road technology features. Rental of vehicles could well become the dominant form over a period of years as the cost of the vehicle increases and the economics become more attractive for spreading that vehicle cost over more utilization per unit of time. In addition, renting rather than owning would be congenial to development of automated guideways because high-productivity rental vehicle companies might be able to afford the investment in necessary equipment, and they could absorb the necessary cost of inspection and maintenance associated with vehicle operations.

Passenger switching systems are requiring vehicles of higher and higher productivity to offset costs imposed by energy, environmental, safety, and increased labor cost factors, and this pressure is resulting in larger and larger vehicles best suited for service in denser markets.

Two emerging factors bear directly on intercity rail transportation. One is the desire of states to augment, using state funding, the basic frame of Amtrak service, so expansion is occurring where there are markets identifiable in state frameworks and where there are institutional arrangements such that funding is available to service those markets. The second matter is more difficult to interpret. Present plans for revitalizing railroad service in the eastern United States call for abandonment of lightly used routes, justified by economics of the rail system. The states, however, argue for the social benefits over and above those of rail system economics, and state subvention of portions of the networks is a distinct possibility. This pattern of subvention might be extended to passenger service.

Some other factors are even more speculative. The emerging pattern of ownership for rail guideways will surely involve major government participation at least in the northeastern United States and may spread to other parts of the country. The question of government participation is not so important as are questions of policy about use of rail guideways and prices charged. Currently, Amtrak pays the railroads the (approximate) marginal cost for operating its trains over the railroad guideways, and Amtrak costs are roughly twice passenger revenues. If some other pricing pattern for guideways were adopted, then the cost situation might change favorably or unfavorably for Amtrak. Improved Amtrak equipment may increase ridership and reduce Amtrak deficits which might encourage

expansion of service. Additionally, policy with respect to provision of service might enable innovative institutions to risk providing service on some routes.

Future development in the Northeast Corridor also requires speculation. Studies and Metroliner demonstrations during the last decade suggest opportunities for investment in higher speed technologies. While it is not impossible to imagine the Congress supporting this regional-specific investment, congressional support would more likely require a broad program with, perhaps, a baker's dozen of corridors around the nation also signaled for development. A pattern of development from current to high-speed to very high-speed rail-like transportation was described in a recent report of the Committee on Transportation of the National Research Council,* although that report did not motivate the possibility of development from the point of view of the political feasibility of programs. The point to be noted is that the technology would evolve in a few well defined markets, and while it may have a nitch in future intercity transportation, quantitatively that nitch would be small.

Turning now to air, there has been extensive study of air vehicles that might serve markets with a short stage length, short takeoff and landing aircraft, for instance. The cost of time when the aircraft is loading and unloading and power and energy requirements for takeoff and landing impose cost penalties on these aircraft. However, they would compete at least in part in collector-distributor modes for which costs of alternative forms for transportation are also high, so there are no doubt nitches in the market where they will prove competitive. An important supporting force is available, namely: the interest of technology supplying organizations. On the other hand, so little is known about the fundamental structure of travel that it is very difficult to judge technological opportunities, and this market will probably be developed by trial and error over a relatively long period of time.

Intercity travel that is not in a dense traffic corridor and within which batches cannot be aggregated to provide dense service by passenger switching systems will not be well served by passenger switching systems. Adapting systems to better serve that market would seem to require software technology that would enable service pooling arrangements to bring batches of people together at the correct times and places so that shared travel is practicable. This might evolve from bus service, although such service might evolve through automobile rental agencies such as the rental of intercity vehicles. Current low-density air service forms might increase demand scheduling to serve small markets. The technology needed is partly that of software, software to aggregate demands so that the service is available at the right time and place, e.g., somewhat similar to car pool or dial-a-ride software systems.

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*Committee on Transportation, *A Review of Short Haul Passenger Transportation*. National Research Council, 1975.

To complete this discussion of the evolution of intercity systems within their present frames, brief remarks will be made on how different markets might be served.

Corridors where traffic is heavy are relatively well served by intercity transportation technologies. Continuing investments in existing technologies, including improving technology supporting the upgrading of railroad passenger service, will continue to serve these corridors. Corridors in this category include, for example, Washington-New York, Milwaukee-Chicago-Detroit, and Houston-Dallas.

Corridors with less dense travel are numerous and include, for example, Seattle-Portland, St. Louis-Columbus (Ohio), and Nashville-Memphis. Alternatives for development include new forms of air technology, gradual expansion of passenger railroad service, and/or evolution of the highway system including both auto and bus.

With the exception of some charter and third level aircraft service, sparse markets are now served almost exclusively by the automobile-highway system. Representative here are three examples: travel from Chicago to numerous vacation sites throughout the Upper Great Lakes; travel from cities throughout overlapping market areas; and other travel circumstances providing access to all points in the country. Where there are links in the Interstate coaligned with this travel, these areas are now relatively well served; they are, of course, less well served if these links are not available. Technology meeting needs in these markets include auto-highway technology, small aircraft and support systems technology, and software technology for demand scheduling.

Remarks above have touched on opportunities for technologies resulting from efforts to obtain efficiencies through economies of scale and resulting from environmental, energy, and safety considerations. *As the intercity system evolves in present directions, some portions of the market will be better served than other portions. This issue may increase demands that technology be evolved to provide service in disadvantaged markets.*

Using Technology to Lead Societal Development

The previous section addressed competition among intercity passenger transportation systems and the probable evolution of those systems, given present technology characteristics and forces for change. The present section will consider the use of technology to support societal development.

First, the ways which technology questions may be asked will be reviewed. The section then ponders the nature of the intercity transportation problem. Finally, properties of societal needs for intercity transportation are discussed.

Asking Questions about Technology Development. The previous section considered the question, given the market as it is currently developing and given technologies as they are currently supplied, what forms of technology development are likely? The same question may be asked without limiting it to technologies that can be supplied by existing delivery systems. In some nations, agencies other than those involved in delivery and operations of transportation technology are charged with R&D on transportation technology, and they tend to pursue technology developments that might be applicable to intercity transportation regardless of their conformality with existing delivery systems. Work on high-speed, magnetically levitated trains in Germany is an example.

The question may be further developed. Intercity transportation deals with the quantities of things to be moved, movement distances, and time parameters. These quantities may be bounded to conform with the characteristics of intercity transportation: for example, distance might be bounded 50 to 250 miles. Additionally, the quantities of dollars, land, or energy for movements may be identified and bounded. The question then can be rephrased, given the boundary conditions and minimization or maximization criteria within those boundaries, and given extant technology and all that might be developed within appropriate time frames, what technologies should be developed and put in place for intercity transportation?

While this might be an appropriate way to ask questions about technology in many circumstances, it does not seem to be very appropriate to the intercity transportation problem. First, intercity transportation impinges on a complicated world of social, economic, technical, and political institutions. To ask questions of what to do without considering how to do it is not very fruitful. Second, transportation is but a means to ends, and it is not very fruitful to examine technology questions without much attention to purposes. For instance, one might examine intercity transportation technologies with the objective of minimizing energy consumption. While social purposes may be associated with the minimization of energy consumption, that is hardly the main social purpose of intercity transportation. It is necessary to define the intercity transportation question in some larger way.

The issue is that the appropriate way to ask questions about intercity transportation technology developments is to phrase them in terms of social purposes. The question is, namely: given social purposes, what developments in intercity transportation are desired and what technologies should be developed and implemented in order to achieve those purposes?

The question is overly simple, in part because it assumes that social purposes can be known; even if social purposes could be known, there are problems of cohesion of views and adjudication among groups that have different purposes. Yet the problem of social purpose is not completely intractable. The future is partly knowable because today's individuals, social groups, and physical facilities will appear in the future in aged forms. Paths for change have to be sought that are conformal with individuals and institutions as they exist today, and as they might be

changed in desirable ways. *An issue is that the paths for change must be feasible and desirable. Feasible paths and the impacts of those paths are at issue.*

What Is the Intercity Transportation Problem? This subsection will treat some societal concerns as problems of intercity transportation. The next will treat concerns more generally.

Intercity transportation hardly ranks as an exposed problem in comparison to equal opportunity, energy, inflation, unemployment, crime, education, welfare, and the environment, yet it is related to several of those issues. In addition, intercity transportation is closely intertwined with recurrent questions of (regional) political powers and resource allocation. The discussion will begin with the latter matter; it will be approached through a consideration of the impacts of transportation development.

Short-run intercity transportation impacts are felt directly by users of the system and by persons or institutions holding resources directly impacted. In the long run, the availability of new transportation service affects investment and disinvestment and leads to what may be described as reorganization impacts. These impacts may work through economic, government, or other institutions, and transportation development may be necessary but not sufficient to those reorganization impacts. Consider some examples.

1. The improvement of rural roads has caused the near disappearance of hamlets in this country; it has affected the growing of subsistence crops on the farm vs. purchasing them in a supermarket; it has contributed to the movement of the homestead from the farm proper to a rural town, and it has changed the style of life in rural areas.

2. Medical service is now highly specialized, and, associated with each specialization, there are market areas of differing size. Transportation improvements enabled in part these developments.

3. Improved transportation has had a sharp impact on warehousing, generally decreasing the numbers of warehouses required for any given service and decreasing inventories.

Improvements in the last decade in intercity transportation over relatively long stage lengths has impacted on economic, social, and government institutions. The general effect of these impacts in major metropolitan areas appears to have been that of centralizing control of institutions as against decentralization. Transportation alone has not occasioned these developments, of course, for computer and communication development have played important roles. Also, the notion of control is subtle. Centralized control with improved transportation and communication may result in increased flexibility for actions by regional units.

The development in the last two decades of the Interstate System has affected the tributary areas of cities of many sizes and the division of activities between larger places on the network vs. smaller places. The links of the Interstate have organized these impacts geographically.

In short, those areas of the country well served by the (longer stage) air net and by the Interstate have been undergoing reorganization and receiving impacts. Places less well served have been impacted by improvements, but seem not to have shared either in the benefits or disbenefits in the same way. They are probably relatively worse off.

There has not been a spatial, institutional, or individual accounting for these impacts on the spatial scale at which they are discussed here, so the remarks above, while undoubtedly in the right direction, are speculative. Even so, they are important to the issue of intercity transportation. At one extreme, an option may provide a spatially distributed set of reorganization impacts. At another extreme, impacts may be mainly limited to selected corridors and places on networks.

The issue of intercity transportation in this context is, then, that of past and future geographical impacts. In this geographical frame, the issue is coaligned with the geographical bases of political power in the federal government and in the states.

Table II-1 allows restatement of the intercity transportation problem. It shows passenger-miles of travel by the four intercity systems. In the case of bus, train, and air, the passenger mileage may be assumed to be mainly intercity. Data presented for the automobile are mostly for travel within urban areas, although about 88% of intercity travel is by automobile. It is the cost per passenger-mile which is chiefly of interest, and intercity automobile costs are assumed to approximate that for city travel. Automobile costs as shown in tables such as this are low. Those costs do not include (a) the time of the driver and (b) several kinds of environmental, safety, and guideway costs. For energy cost reasons (mainly), automobile costs are increasing faster than costs of other systems, and automobiles are viewed as wasteful of energy. In addition, costs in nonautomobile systems are a function of economies of scale and would decrease if there were additional ridership. Society would, then, be better off if the competitive position of the passenger switching systems were enhanced and automobile travel eroded.

An issue of intercity transportation is that its present physical format is viewed as wasteful of resources; change to more efficient modes is needed.

In an early section of this paper attention was given to the ways in which vehicles, guideways, and operations created and delivered technologies to the system, and the existence of constraints was noted. Given these conditions, what actors and institutions do within the systems must be considered rational. That is, within the regulatory and institutional conditions within which they work, actors and institutions rationally allocate investment resources and develop and create operating procedures.

Table II-1

OPERATING COST PER PASSENGER-MILE

Vehicle Type	Passenger-Miles ($\times 10^6$)	Operating Expenses ($\times 10^6$)	$/Pass-Mile
Automobile	2,170,095	$111,636	$0.05
Intercity Bus			
Class I	13,576	689.6	0.05
Other	12,024	192.5	0.02
Train			
AMTRAK	3,038	286	0.09
Air			
Domestic Trunk	105,997	8,024	0.08
Local Service	8,899	921	0.10

Sources: Aviation Daily, *Aviation Daily's Airline Statistical Annual,* Ziff-Davis Publishing Company, Washington, D.C., 1974.

Gay, William G., U.S. Department of Transportation, *Summary of National Transportation Statistics,* DOT-TSC-OST-74-8, U.S. Government Printing Office, Washington, D.C., June 1974.

National Association of Motor Bus Owners, *Bus Facts,* Washington, D.C., 1973.

The question of rationality may also be addressed to the boundary conditions within which a particular system operates; it is that of whether these conditions represent rational ways to allocate national resources. The positive argument is that these conditions were established over a long time period and represent an adjudication of the desires of the citizenry in the allocation of national resources. The negative is that the adjudication of interests of the citizenry has been crude at best. Political power and interests have changed. Furthermore, the environment has changed radically. The negative argument now seems to override the positive.

Consequently, *the nature of intercity transportation boundary conditions poses an issue: in particular, the regulatory system is wasteful of resources and restricts service options.* Adjustment of regulatory provisions may provide new opportunities for technology development and

While regulatory conditions may change to permit more flexibility in the pursuit of markets, constraints having to do with environment, safety, labor relations and working conditions, and so on appear to be increasing in weight. Consequently, one should not infer that technology development and delivery systems would necessarily be less bounded in the future; one can infer only that boundaries would be different.

Private sector groups in the transportation community and the secretarial level U.S. DOT officers provide a power base for recognition of the boundary conditions problem.

Socially Desirable Attributes of Intercity Transportation. The previous subsection reviewed some facets of the intercity passenger transportation problem. This subsection will consider the properties intercity transportation should have if it is to conform to social objectives, needs, desires, or wants.

The paragraphs that start the discussion will present some social objectives rather tersely. The discussion will then turn to desirable attributes.

Efficiency is a social objective for the simple reason that society has many wants and can approach more of these if it operates its components efficiently rather than inefficiently.

Reduction of the maldistribution of goods and services is also a social objective. The distribution of access to intercity transportation systems is less than perfect because of barriers. Money is one such barrier, skills for utilizing the facilities are another. In the instance of the automobile which provides much of intercity transportation, those who cannot drive (some one-third of the persons of eligible age do not have drivers' licenses) are limited in access as are those who cannot afford to purchase (or rent) and operate an automobile.

Access to the system is a partial consideration. What is desired is access to those activities that travel makes possible, so the broader issue is that of access to full participation in social and economic life. Not only is this desired for different economic groups and groups with different skills, it is desired for persons regardless of their geographical positions. Adding slightly to this and putting it in a different way, a goal of regional economic and social development may be recognized. This goal is recognized in part because appropriate development is necessary to creation of opportunities to be achieved by travel, and it is recognized in part because it is responsive to the political institutions of the nation. The nation is a federalism. Requisites are divided among the national government, state governments, and local jurisdictions; and political power and institutions are such that geographical equity in the form of geographical or regional development is a goal of the system.

The discussion will turn now to desirable attributes of intercity transportation in light of social wants. In the style of this paper, these attributes will be expressed as issues.

One attribute is that of variety. The issue is that technology must be developed and delivered in many different forms. There are numerous reasons for this. One stems from the federalized nature of the national structure: in many markets that must be satisfied. A single technology and technology delivery program to meet some narrowly prescribed goal, say, to link all cities with populations greater than two million by high-speed ground transportation, is simply unrealistic in light of the division of political and other powers. Variety is also required because environments differ; there are differences in regional goals.

Incrementalism, or suitability to incrementalism, is another issue; it would appear to be a necessary attribute of intercity transportation development options. This issue properly recognizes the inability to determine exactly the values of any alternative program; it recognizes the existing technology delivery system and the numerous other institutions that form the starting context for development.

Flexibility is another desirable attribute; it is not guaranteed by incrementalism. The issue is that developments ought to go forward so that many options are kept open in response to the evolution of social goals.

An important issue is that short-term benefits should be given high value and short-term disbenefits should be heavily weighted. This attribute recognizes the importance of the paths through which change is achieved and that these paths must be desirable of themselves. So paths that have low levels of benefits and/or sharp disbenefits are not tolerable.

The final issue is that benefits from development must be distributed geographically by income and class. This attribute stems from the discussion of maldistribution and regional development.

Further Discussion

This section will enlarge upon two of the themes introduced in previous sections. First, the concept of admissible technological developments will be introduced and used to integrate the discussion of desirable attributes of intercity transportation with materials presented earlier. The section will close with a note on the automobile-highway system, an extension of earlier remarks on that system.

Admissible Technology Developments. It will be useful to review the previous discussion. A number of pages were devoted to an eclectic review of the forms in which intercity transportation is supplied. Competition and laissez faire developments were then discussed. Raising the question

of intervention in favor of social wants changed the structure of the discussion rather sharply. Such intervention requires that there be some measure of the desirability of alternatives and an ability to create and weight them. Some of the attributes that normative choices must have were developed in the preceding section, and the technology will now be discussed in light of these. The term admissible is used to describe the technology developments to be discussed here. These are admissible in the sense that they do not violate the identified attributes.

Consider, first, technological developments relative to guideways: rail, highway, and air. The geographic network of these is very extensively developed, but they usually operate at much less than their capacity (most capacity problems are at switches) and they are subject to strong economies of scale: the more the traffic, the less the unit cost. Currently, many candidate technology developments are screened by their marketability at points where economies of scale may reduce costs. However, excepting the efficiency condition, desirable attributes of technologies suggest that these developments are being screened by the wrong market. More to the point, the market identified by economies of scale possibilities is such that many technologies produced for it do not lend themselves to widely distributed (perceived) geographical benefits. It may be that many current laissez faire technology developments would not be admissible if they were considered *de novo*, especially strategies that fail distributive tests.

The issue of distribution may be attached to the goals for intercity transportation development and to the physical facilities, services, and benefits that accrue from such goals. This sharply differentiates an intercity transportation program from those which strive for national goals such as defense and space exploration.

The local impacts of intercity transportation development are so blatant that they cannot be ignored in any stage of program development, including the technological stage. Boundaries are set sharply on the disbenefit side. Noise, other environmental pollution, massive taking of land, and sharply felt fiscal requirements are untenable. The first incidence of benefits is to those individuals who might perceive shorter travel times, cost reductions, safety improvements, and improved quality of service. There is also a first incidence benefit on land: an immediate consequence of transportation development is that it shifts the comparative advantage of places, which is reflected in land values. Less directly felt are benefits (and disbenefits) from institutional reorganization resulting from changed transportation services.

An issue, then, is that in addition to serving a market in an economic sense, the technology must also respond in a political sense. That is, the technology must touch enough people favorably (and a few unfavorably) so that they perceive benefits and are willing to engage in collective action, say through voting, to provide system implementation.

On account of the extant investment in institutions, guideways, and vehicles and because of the requirement for incrementalism, technologies

must find their market within existing systems. Doing something other than following the existing path is most difficult, for technologies must serve their existing markets and must involve in their development and implementation existing actors and actor relationships, individuals, and institutions. *Another issue, then, is that one cannot separate considerations of technological development from considerations of technology delivery systems.* This point cannot be made too strongly. There exists a duality between the technology delivery system and the kinds of technologies that are deliverable. Consideration of alternatives to technologies currently developable and deliverable requires study of alternative ways of developing and delivering those technologies.

To further examine some of the properties of technology, it is useful to return to the economy of scale issue. Figure II-9 generalizes to total transportation cost the sum of guideway cost, vehicle operating cost, and infrastructure cost. Any point on the line marked A-A' represents that

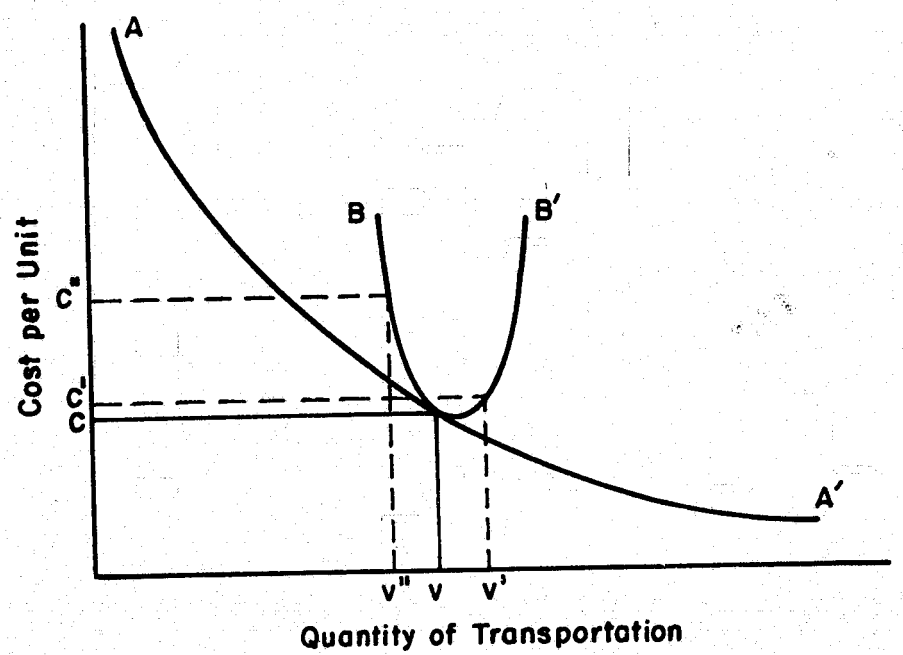


Figure II-9. COST PER UNIT VERSUS THE QUANTITY OF TRANSPORTATION: IN GENERAL (LINE A-A') AND FOR A PARTICULAR TECHNOLOGY (LINE B-B')

form of guideway, vehicle, and management providing the minimum cost for moving a given number of units (e.g., v, c). It is always possible to

provide transportation at higher costs, so that all the points lying above A-A' represent ways in which a wasteful technology could be supplied. Another way to think of line A-A' is that it represents the tangent points of curves such as B-B'; B-B' describes the cost characteristics for some guideway, vehicles, and operating institution combination. For instance, B-B' might be thought of as the cost vs. quantity relationship for a particular rail length with the capacity of the length, the number of vehicles, and the form of operation fixed. In both theory and practice there would be a very large number of B-B' relations representing the technologies of intercity transportation.

The market for technology as it is currently channeled and realized focuses on technology developments on the right-hand side of A-A' . The main reason for this is the search for scale economies.

Figure II-9 nicely illustrates a flexibility problem; as shown, the number of units moved has a time dimension, hourly, daily, yearly, or so forth. But demand per unit of time is never constant. A system such as B-B' might be selected to provide service level v at cost c , yet, demands on the system might vary from v' to v'' and costs from c to c'' . Consider:

1. v and c can never be forecast exactly. Further, v and c for any route can be expected to change over a series of years as urban centers grow or decay and as patterns of travel change. Consequently, the nature of the curve B-B' indicates the degree of the risk of putting that technology in place for a particular service. Generally, one would prefer technologies that generate curves more with a shape.

2. Once this system is in place, v and c can be measured and improved estimates made of how they might shift over the years. A wise manager would do this and then shift investment in light of changes. The question arises of the extent to which the installed technology lends itself to disinvestment or investment as needed. Generally, where heavy investment is made in guideways, a system is not very flexible. The number of vehicles in the system can be increased or decreased and switches may be more easily increased or decreased in capacity than may guideways.

The Automobile-Highway System. The automobile-highway system is changing mainly because of environment and energy considerations. Because the political and social climate seems to favor change, and because many technological changes seem admissible, a short note will be included here on this system. Some remarks made previously will be repeated.

The automobile in its current form has a life of approximately ten years and is driven approximately 100,000 miles. Assuming an average occupancy of 2.2 persons per vehicle, it delivers approximately 220,000 passenger-

miles of service during its lifetime: 22,000 passenger-miles per year, 60 passenger-miles per day, or 2.5 passenger-miles per hour. These latter numbers are not very usable because automobile utilization is a function of its age, the newer the car the more it is used. Also, daily and hourly utilization varies greatly as does the utilization of one automobile compared to another. In addition to these temporal variations and user to user variations, the automobile is used in different driving environments, e.g., on access streets or freeways, and is used for a wide variety of purposes or trip types. The automobile is a general purpose vehicle adaptable to many circumstances but perfect for none.

Small lightweight vehicles are one direction in which suppliers are responding to environmental and energy problems. Another direction might be that of developing special vehicles for medium- to high-speed driving using favorable aerodynamic configurations and involving suitable gearing, fuel metering, and other elements to reduce fuel consumption. These vehicles would be expensive. Also, investments in aerodynamics and expensive propulsion systems might not be competitive with investments in weight reduction and the reduction of propulsion plant size for travel on local access streets and arterials.

The market may thus diverge in two directions: lightweight urban vehicles and medium- to high-speed, special purpose, over-the-road vehicles. Such divergence could be aided by institutional forms to increase the productivity of over-the-road vehicles. The garage of the future might have one or more lightweight vehicles. It would also contain an over-the-road vehicle if that vehicle were used enough for that special purpose to warrant the ownership. Over-the-road vehicles might be rented as needed.

This pattern of development would allow the automobile-highway system to respond to both technology developments and social problems. The social problem is that there is a lack of access to the system either because persons are not licensable or because vehicles are too costly. The inexpensive light vehicle could ameliorate cost problems. The accessibility of the system could be ameliorated by licensing procedures tailored to particular vehicles and environments. For example, the subteenager might be licensed to drive a lightweight vehicle on local access roads only. Such a vehicle might have sharp limitations on horsepower and stringent braking requirements. The vehicle itself might not be registered to operate on, for example, freeways.

With intensive utilization, the over-the-road vehicle could warrant investments in guidance systems, and an evolutionary path could be developed leading to full automation of freeway lanes and vehicles. There is a clear advantage of this from an energy point of view because over-the-road vehicles could have rather small propulsion plants, used at near full load most of the time. Spaced control would be necessary to manage the differing average speeds uphill and downhill that would occur under such a mode of propulsion plant utilization. Development of energy storage systems, a carbon fuel engine, generator, batteries, and an electric motors system,

e.g., would provide an alternative to dynamic speed controls. Additionally, the guideway system could be modified to provide a form of dual mode, and properly equipped chassis could be rented for transport of lightweight vehicles and/or special purpose vehicles such as campers.

This direction of development could well have public support. It would support widely distributed benefits for its geographical impacts would be widespread. It would deal directly with two widely perceived problems of the automobile: it insults the environment and uses up energy. It would also deal with the problem of accessibility to the automobile-highway system by persons of different age and income classes.

It should be remarked that there are some major impediments to this direction of development. For one, it would require a level of joint decision-making by driver and vehicle licensing agencies, institutions providing insurance and other factors affecting operations, guideway suppliers, and vehicle suppliers. Such joint decision-making does not currently exist. Additionally, such development would require the involvement of new kinds of actors in the technology and delivery process. For these reasons, the special purpose vehicles discussed here might be described as marginally admissible.

Closure

This paper has approached the issues affecting intercity transportation by discussing the forms of that transportation and the ways in which its technology is and has been produced and implemented. How those forms might evolve in the absence of deliberate attempts to attach intercity transportation development to social desires was then discussed. Questions about the relationship of technology to social desires were then considered.

The process of technology development and deployment requires imaginative actors with a sense of purpose, sponsors of research and development, and the important follow-on of activities of testing, production, and implementation, and clients or markets. On reviewing current intercity transportation systems, one notes many unfavorable conditions when the current process is matched against the issue of using technology in conformality with broadly viewed social purposes. The supplier institutions are quite fragmented, and actors within those institutions have restrained roles. Much of the technology represents an amalgamation of know-how developed in engineering and other fields in light of the progress of those fields and their images of goals. Nowhere is there a coupling between the needs of transportation broadly conceived and deep streams of scientific and technological work. The market is fragmented geographically and in other ways. Because of lack of knowledge of the market, it is viewed mainly as opportunities for efficiency from economies of scale in existing systems. No one searches for unmet needs and new opportunities.

One can speculate whether society has had a rich selection of technological options from which to chose. Have the forms of the technology development and implementation systems been such that society has only a meager fare?

So one may incline to the view that the problem of intercity transportation is that while many are involved it is nobody's business. There is no well known and cohesive market structure that demands that technology meet its needs. There is only a fragmented technology implementation structure that is limited in what it perceives and can do. This poses an opportunity for creation of imaginative technological institutions and for actors within those institutions. The creation of a variety of technological opportunities and the appropriate representation of these to the public would assist public decision-makers in identifying what is desired and options they wish to seize. The development of technology options need not be simply guided by the rule of developing a technology because it is developable. Rather, the development of technological options should be guided by careful evaluation of the determinants of travel and of the conditions within which options may be deployable.

III. CONSTRAINTS TO THE IMPLEMENTATION OF INTERCITY TRANSPORTATION INNOVATIONS

by

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ABSTRACT

This paper considers those elements in the process of innovation relevant to intercity passenger transportation. It identifies the participants in the process and explains the resources required to implement a successful innovation. The objective is to identify those factors aiding or impeding the successful introduction of a new technology.

The innovation process is complex; it begins with conception or invention, goes through research and development stages, and finally must pass through the "technology delivery" phase in order to reach the market. The technology delivery aspects of the process of innovation include all matters related to production, marketing, and distribution of the innovation.

Five distinct parties to the process of innovation in intercity transportation systems are carriers, both public and private; travelers and shippers; suppliers to carriers of infrastructure, equipment, services and capital; government--all levels and all roles including regulation, supplier, user, promoter, and "environment creator"; and the general public.

Frequently the carrier is the innovator, instigating and shepherding the innovation through the multistep process. Some carriers may simply reject out-of-hand technological innovations in general or those of a given character. Others typically embrace certain types of technological innovations without detailed economic analysis. Carriers owned by the public sector appear more willing to accept the substantial risks associated with dramatic technological change than do their private sector counterparts.

The consumer/traveler plays a major role in determining the rate at which innovations are adopted. There is a substantial interaction between carriers, shippers, and travelers. This interaction determines the success of a given technological innovation in the market place.

Suppliers to carriers may produce services in the form of studies and analysis associated with the introduction of new techniques and new technology; or they may produce equipment for use with the infrastructure, including railway locomotives and cars, aircraft, ships, hovercraft, etc. Additional suppliers are those who furnish capital to the transport sector. Such financing, of course, is a critical factor in the determination of the extent to which new concepts will be implemented.

Government can alternately be supplier, shipper and sponsor of travel, promoter of transport, and creator and shaper of the economic and social environment in which transportation is produced and marketed.

Although public attitudes can be conditioned by actions of carriers, suppliers, and government this does not negate the hypothesis that the

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general public in the long run plays a significant role in determining which transportation innovations will be undertaken and introduced and how successful they will be.

Constraints to innovation in intercity transportation can be divided into (1) resource constraints, and (2) social constraints and incentives.

There are five basic categories of resource constraints that can be identified with respect to transportation innovation: basic technology, capital (public or private), labor, management, and land.

For the next quarter century, there are an abundance of technological possibilities to support any kind of transportation innovation that is either required or desired.

Means must be found to minimize the extent to which innovative processes relative to intercity transportation are held up awaiting completion of the R&D results required to make given technological innovations physically and economically viable.

Financial resources provided for intercity transportation emanate from both the public and private sectors, depending, of course, upon the nature of the resources required, the way in which they will be applied, and the public policy of the moment.

By and large, the labor constraint is manifested through a shortage of personnel with special skills required either in the development or application of transportation innovations. Labor constraints also grow largely out of public policy which generally does not condone wholesale labor displacement resulting from technological or organizational change.

The availability, quality, and quantity of management are also resource constraints to innovation. The mixture of public and private sector management in itself creates problems with respect to the allocation of resources to support innovations in intercity transportation. The public enterprise manager generally has less incentive to innovate successfully than does his private sector counterpart.

While land constraints may be felt in the next half century more in the context of urban transportation than interurban, there will certainly be an increasing number of instances in which a given set of technological possibilities related to intercity transportation cannot be exploited. Development of high speed and efficient tunneling techniques is one means of easing the growing land constraints.

Social constraints and incentives include regulation of all kinds, public policy, and labor.

Regulation represents one of the major social constraints to technological change and innovation; it can, however, also provide a substantial

incentive. Regulators will increasingly become aware of the relationship between economic and other forms of regulation and technological change.

The factors that influence intercity transport innovations include government as promoter of transportation, maintaining balance in the transportation sector, market aggregation, purchasing philosophy and techniques, test facilities, foreign technology, appreciation of innovation as a process, and innovative propensities.

Regulation is a device that is both promotive and restrictive. Government funds research and development, provides operating subsidies, and provides infrastructure. An important issue is whether government will recognize its potential as a promotive force and whether it will use its leverage to serve the explicit ends of public policy.

A balanced transportation system is one that is responsive to all the needs of the traveling and shipping public while providing them with a choice of mode and method wherever possible. It is achieved through coordinated allocation of public and private funds.

Market aggregation refers to the willingness and ability of buyers (carriers) to define collectively their needs and to pool their purchasing power in order to induce suppliers to provide a higher quality or more efficient product or service. The federal government achieves market aggregation when it imposes standards that cause technological innovations.

Purchasing philosophy involves the means by which transport enterprises acquire infrastructural components and equipment. A performance-specification approach to purchasing will have a beneficial influence on technological innovation.

Foreign technology represents a particularly important potential spur to domestic technological innovation. The availability of foreign products embodying different and better technology should induce manufacturers to produce competitive or superior equipment.

One drawback to technological innovation is the lack of test facilities. Facilities to test mundane equipment such as railway freight cars and locomotives are necessary.

Those involved in innovation must recognize the continuum of the innovation process, from conception through R&D and production, and finally to the marketplace.

Unless society and transport sector entrepreneurs (public and private) embrace technological innovation, the likelihood of there being significant technological change in intercity transportation in the next 25 to 50 years is relatively small. Though there is currently widespread

public disenchantment with technology, it is expected that the propensity to innovate in transportation will increase.

Constraints over the next 25 years are largely expected to be institutional, related to definitions and assumptions of responsibilities by various parties to the process of innovation in the transport sector. Three crucial independent variables are the locus of regulation, the balance between competition and economies of scale favored by national policy, and social awareness. The locus can be either highly centralized or highly decentralized. Centralized authority tends to produce consistent and definitive regulation; it also tends to lack broad-based, multifaceted appeal mechanisms. Decentralized regulation tends to produce overlapping and potentially conflicting regulations.

There is always a balance struck in the transportation industry between emphasis on competition and emphasis on benefiting from economies of scale.

Social awareness is characterized by the degree to which economic issues such as concern for the environment, the interest of special interest groups, social equity, safety, and security are recognized and function as important constraints in the implementation process.

Eight scenarios, resulting from various possible combinations of the extremes of the above independent variables, close the paper.

III. CONSTRAINTS TO THE IMPLEMENTATION OF INTERCITY TRANSPORTATION INNOVATIONS

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III. CONSTRAINTS TO THE IMPLEMENTATION OF INTERCITY TRANSPORTATION INNOVATIONS

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Introduction

The principal subject of this paper is technological innovation. The concern is with getting new technology into the marketplace or, more precisely, with determining the issues that influence the introduction on a significant scale of technologically innovative infrastructure and equipment for intercity transportation. The technological possibilities in the various fields are considered in other issue papers in this report. The focus here is upon the issues and forces affecting the "delivery" of the technological possibilities to the marketplace.

It is not enough for a product or service to be conceived or that research and development activities produce a piece of hardware. If the process of innovation is to be completed, the product or service that has been the object of the process must be introduced into the marketplace. The innovation process is complex; it begins with conception or invention at the extreme furthest from the marketplace, goes through research and development stages, and finally must pass through the "technology delivery" phase in order to reach the market. A generalized and typical relationship between various key elements in the process of innovation is shown in the accompanying flowchart (Figure III-1). The technology delivery aspects of the process of innovation include all matters related to production, marketing, and distribution of the innovation.

It is in the technology delivery phase of the innovative process that by far the greatest resources are required. Numerous studies have shown that typically some 90% of the total resources required to carry through the process of innovation are, in fact, expended beyond the R&D phase of the process. Completion of R&D activity merely provides the opportunity for the innovating organization to reach the market with a believable technological possibility; but to realize this opportunity, it generally must be willing to commit to the delivery task many times the resources that it has expended up to this point in the process.

This paper is concerned with all the elements in the process of innovation relevant to intercity passenger transportation. It identifies the participants in the process and explains the resources required to implement a successful innovation. The objective is to identify those factors aiding or impeding the successful introduction of a new technology. The focus, therefore, is on those forces that affect the speed and direction of the entrepreneur--public or private--as he attempts to move through the process because these are the principal factors affecting implementation of the innovation.

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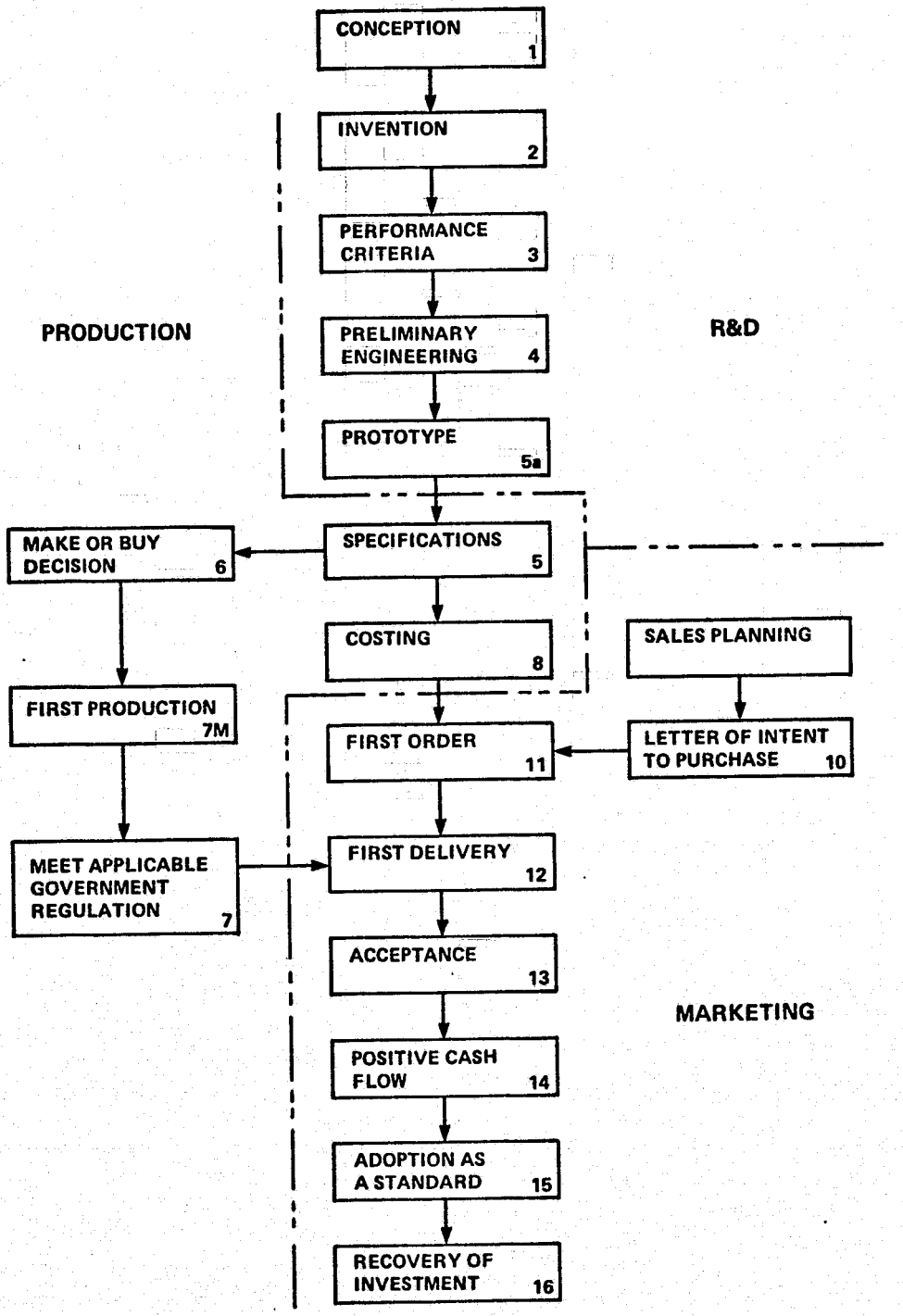


Figure III-1. KEY ELEMENT MODEL OF THE PROCESS INNOVATION

Parties to the Process of Innovation

Five distinct parties to the process of innovation in intercity transportation systems can be identified. They are:

- Carriers, both public and private
- User, that is, travelers and shippers
- Suppliers to carriers of infrastructure, equipment, services, and capital
- Government: all levels and all roles including regulation, supplier, user, promoter, and "environment creator"
- The general public

Each and every public and private entity involved in supporting, producing, or using intercity transportation has a critical role to play as far as the process of innovation is concerned. Some of the roles are quite obvious and others are far more subtle though nonetheless influential.

Carriers. One of the critical participants in the process of innovation is the transportation company. Frequently the carrier is the innovator, instigating and shepherding the innovation through the multi-step process.

Consider the role of the carrier. Transportation companies can, and often do, play "dog-in-the-manger." For reasons that may or may not be rational, some carriers may simply reject out-of-hand technological innovations in general or those of a given character. Other carriers typically embrace certain types of technological innovations almost without detailed economic analysis. Perhaps the best example of the latter would be the approach to innovative aircraft taken by scheduled, certificated airlines. Certainly, the widespread and quite rapid adoption of the Boeing 747 by some primarily domestic carriers is a case in point.

In some cases the extent to which innovation is embraced by carriers depends on whether such carriers represent public enterprise or private enterprise activities. Except in the area of urban transportation, the United States has had little experience with public enterprise carriers. In foreign countries, differences in attitude between public and private carriers have been evidenced. Those owned by the public sector appear more willing to accept the substantial risks associated with dramatic technological change than do their private sector counterparts both in the same country and in other nations. Indeed, outside the U.S. at least, the propensity to accept innovations embodying substantial technological change seems to be greatest in publicly owned transportation

companies where the public sector also has a substantial stake in the enterprises that provide the hardware associated with the innovative transportation product.

Travelers and Shippers. Those who travel or ship obviously play an important role in determining which technological innovations will be successful and which will either be stillborn or will be introduced without financial success, however measured. To the extent that the traveling public rejects a given form of transportation, such transport cannot become a significant factor. The same is true where the shipment of goods is concerned.

In this connection, there are instances where travelers (and shippers occasionally) embrace a technological possibility that, whether economically rational or not, provides an opportunity for profit for carriers or transport equipment makers. The automobile and the private aircraft are two examples. In either instance, the traveler is producing his own transportation, and it is he who principally, although not exclusively, makes the associated capital investment decision. Such decisions are frequently nonoptimal and hence not economically rational. Nevertheless, the influence of the consumer/traveler should not be underestimated. He plays a major role in determining the rate at which such developments as innovative types of automotive power systems will be adopted.

Where public transportation is concerned, certainly carriers can influence the propensities of travelers and shippers to accept technological innovation. Carrier marketing programs are often dedicated to such effort. The point, of course, is that there is substantial interaction between carriers on the one hand and shippers and travelers on the other that determines the success of a given technological innovation in the marketplace.

Suppliers to Carriers. Serving as a key factor in determining the extent to which technological innovation will succeed or fail are the suppliers to carriers. (In this sense, the term "carrier" includes operators of automobiles and private aircraft who supply transportation services to themselves.) The suppliers having a profound influence on the process of technological innovation in intercity transportation span a wide spectrum of services and products. For example, they may be contractors building highway systems, municipal airports, or railroad rights-of-way; they may produce services in the form of studies and analyses associated with the introduction of new techniques and new technology; or, they may produce equipment for use with the infrastructure, including railway locomotives and cars, aircraft, ships, hovercraft, etc.

Often overlooked in the category of suppliers are those numerous organizations that furnish capital to the transport sector. These entities in the United States are both public and private. For example, until

recent years, private lending institutions provided the bulk of railroad capital. With the launching of AMTRAK and the current reorganization of the Northeast railroads, there has been an increase in public sector participation in supplying capital to railroad enterprises. In the highway mode, the suppliers of infrastructure capital are largely public agencies whereas equipment capital, especially for intercity transportation, comes almost entirely from private sources. In aviation, capital supply follows substantially the same pattern as in highway transportation. Regardless of the source or form (loans, equity, debt, or leases) of the capital, the willingness of capital-suppliers to finance innovation both on the part of suppliers to carriers and of carriers themselves is a critical factor determining the extent to which new concepts will be implemented.

Government. Government at every level is involved with transport innovation. Even in modes such as rail where government, until quite recently, has had minimal direct involvement from a financial standpoint, the role of the government is presently very substantial and promises to grow, at least in the near term. Government actually plays several different roles: those of supplier, shipper and sponsor of travel, promoter of transport, and creator and shaper of the economic and social environment in which transportation is produced and marketed. In each and every role, it exerts substantial influence on the development and successful implementation of technological innovation in intercity transportation. Since governments are so influential in this respect, considerable subsequent discussion will be devoted to their role in specific contexts.

General Public. The general public often plays a significant role in determining which transportation innovations will be attempted and which will be ultimately successful. This is particularly true since government plays so many roles, and plays them so powerfully, and since government, by and large, is sensitive to public attitudes in conceiving and implementing policies that affect transportation both generally and specifically. If the public at large rebels in dramatic fashion against aviation-related noise, government can be expected to take steps to force aircraft and airport operators to make the operating and technological changes necessary to keep noise within acceptable bounds. Although public attitudes can be conditioned by actions of carriers, suppliers, and government, this does not negate the hypothesis that the general public in the long run plays a significant role in determining which transportation innovations will be undertaken and introduced and how successful they will be.

Constraints to Innovation

The constraints to innovation in intercity transportation can reasonably be divided into two broad categories: (1) resource constraints* and (2) social constraints and incentives.

Resource Contraints. There are five basic categories of resource constraints that can be identified with respect to transportation innovation. These are:

- Basic Technology
- Capital--Public and/or Private
- Labor
- Management
- Land

Basic Technology. Essentially, technology is knowledge. In this context, the term refers to scientific or technical information that leads to production of a specific good or service. New technology, or existing technology applied in a new way, is at the foundation of all technological innovation. In contrast, nontechnological innovation involves new applications or new marketing methods for an established product in the expectation of eliciting additional demand or of shifting the user's cost function.

With the technological possibilities that are available to produce transportation innovations, it would seem that in the near term, perhaps for the next quarter century, there are an abundance of technological possibilities to support any kind of transportation innovation that is either required or desired. The science underlying the development of technological possibilities (through research and development efforts) is quite abundant in the United States. Basic problems arise primarily with respect to working through the process of innovation beyond the R&D phase.

This is not to say that all support for R&D activities oriented toward transportation should be eliminated in either the public or private sector, but rather that the greatest barrier to the implementation of intercity transportation innovations are in the "technology delivery"

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*Note that the resource constraints can be recast as the resources required to innovate successfully.

system rather than in the steps in the process of innovation that lie upstream from technology delivery.

As the technological possibilities that now exist are exploited more fully in the context of transportation, there will certainly come a shortage of exploitable R&D results. Means must be found to minimize the extent to which innovative processes relative to intercity transportation are held up awaiting completion of the R&D results required to make given innovations physically and economically viable.

If any area of transportation is presently experiencing a significant shortage of technological possibilities, it must surely be that encompassing the mundane aspects of intercity transportation. Public sector sponsors of transport-oriented R&D activities have for the most part focused upon dramatic technological solutions to perceived transport and social problems. Significant public and private funds have been devoted to developing very high-speed ground transportation hardware and systems and supersonic transports, while precious few resources have been allocated to provide the much-needed means for braking railway trains in such a way as to lessen damage to cars and their contents, to permit use of lighter weight equipment, and to reduce maintenance costs both with respect to equipment and infrastructure. In any case, the technological possibility gaps left by failure to focus upon the requirements for what have been called the "unexciting R&D" needs of the transportation sector are relatively easily filled if there is leadership to divert resources from dramatic R&D activities to those with less exciting but very significant short-term payoffs.

Capital. One of the most obvious constraints in terms of resources relates to the capital devoted to innovative activity. Financial resources provided for intercity transportation emanate from both public and private sectors, depending upon the nature of the resources required, the way in which they will be applied, and the public policy of the moment. Shortages of capital can be traced to either the public or private sector. In any event, the capital can be provided in myriad ways, such as through grants, loans, sales of equity, in-kind contributions, etc. The method of providing the capital sometimes affects the process of innovation involved but most often it does not.

One special problem associated with public capital, where innovation is concerned, relates to the general public policy toward the proprietary rights of the inventor or innovator. If public funds are involved in developing a given item of hardware or a given transport system, the public sector retains at least nonexclusive, royalty-free rights to use the patents and know-how generated as a result of the particular project. In many instances, private sector entrepreneurs with concepts promising external benefits substantially in excess of external costs are aborted in their innovative programs by the existence of these constraints on the use of public funds provided in support of such activities. There

is some indication that Congress and other legislative bodies are becoming more sophisticated in this area. Such a change in policy would add substantial impetus to the development of technological possibilities and innovations in the intercity transportation field.

Labor. Labor represents a resource constraint in some instances. By and large, the labor constraint is manifest through a shortage of personnel with special skills required either in the development of transportation innovations or in the widespread application of such innovative hardware techniques. It is doubtful that there will be a shortage of labor in the foreseeable future in the United States, but it is entirely possible that shortages in certain high-technology skills will severely constrain the extent and rate at which certain innovations can be diffused throughout the economy.

Management. In a similar vein, a significant but less obvious resource constraint to innovation in the intercity transportation field is the availability of management in a quantity and of a quality necessary to support the implementation of transportation innovation on a broad front. There are several reasons why the management constraint can be a quite severe one. First, transportation has too often not been a profitable field of endeavor within the private sector. Without the resonable probability of achieving a profitable result, management has less opportunity to exploit the frontiers of technological possibility. Thus, management talent is less inclined to enter transportation than those fields in which greater opportunities for profit are present and especially those in which successful innovation could be achieved. Many management rewards, psychic as well as financial, flow from successful technological innovation. Where these rewards are not realizable, for whatever reason, skilled, aggressive managers tend to shy away.

The problems of transportation management are compounded by the substantial activities that are provided and managed in the public sector. Indeed, except for the railroad and pipeline forms of transportation, there is at least a mix of public and private sector management involved in intercity movements. Airports, for example, are provided and managed by public sector entities while air carriers are generally private sector enterprises in the United States. Intercity rail passenger service is increasingly provided by AMTRAK, a public corporation, but the railroads over which AMTRAK operates are, for the present at least, owned by private firms. The mixture of public sector and private sector management, in itself, creates problems with respect to the allocation of resources to support innovations in intercity transportation.

But the most significant point for present purposes is that the public enterprise manager generally has even less incentive to be entrepreneurial and to innovate successfully than does his private sector

counterpart, even in the field of regulated intercity transportation. At least the private sector manager has a profit and loss statement to indicate in a general way how well he is performing in the marketplace. The public sector manager has no such yardstick and the net result is that the latter cannot generally know the extent to which innovations have been successfully introduced any more than he can know whether he has been managing skillfully in a general sense.

The absence of surrogates for the profit and loss statement and balance sheet available to private enterprise not only denies the public sector manager a convenient means for gauging his performance in absolute terms, but it also denies him the ability to determine how he is doing in comparison with his peers operating other public sector facilities of a similar nature. Without such devices, it is generally thought that public enterprise managers are less skilled than their private sector counterparts and that they allocate resources less wisely. In this sense, management quality imposes a significant constraint on the implementation of intercity transportation innovations.

Land. Land or real property represents a very subtle resource constraint in the context of intercity transportation. However, as land is more intensively used in the United States and as population increases and land becomes increasingly costly in many locations, the lack of availability of real property will become a severe restraint on certain types of transportation innovations. While the constraints may be felt in the next half century more in the context of urban transportation than interurban, there will certainly be an increasing number of instances in which a given set of technological possibilities related to intercity transportation cannot be exploited primarily (or perhaps solely) because of a shortage of land to accommodate the particular innovation. Most certainly, assembly of a new right-of-way is a principal barrier to construction of a Tokaido-type rail line in the Northeast Corridor.

One expectation is, of course, that as land constraints become more severe, increasing emphasis will be placed upon developing technology to relieve such constraints. Much attention has been paid in the recent past and will continue to be paid in the future to the development of high-speed and efficient tunneling techniques as one means of easing the growing land constraints.

Social Constraints and Incentives. Social constraints and incentives can be divided into three general categories:

- Regulation of all kinds
- Public policy
- Labor

Regulation. Many different kinds of regulation apply to the production and use of intercity transportation. Virtually every regulation carries with it some implications for the process of innovation in the industry or area being regulated. Consequently, regulation represents one of the major social constraints to technological change and innovation.

It should also be noted, however, that regulation can also provide a substantial incentive to certain types of technological innovation, especially in the fields of transportation where so much of the activity of transportation enterprises is circumscribed by regulations of various sorts. Two contrasting examples will perhaps serve to make the point.

Consider the domestic airline industry in the United States where the Civil Aeronautics Board regulates rates in such a way as to assure that identical fares will be charged in each intercity market for the same class of service. In such a regulatory environment, carriers and their suppliers will focus on every conceivable way to provide a service to the public that can be differentiated on every basis except rate or price. The net effect of such a rate-identity regulatory philosophy is in part to stimulate technological innovations that may not produce more efficient or more effective transportation but merely transportation with a difference.

Such distortion of the process of innovation comes into play in the regulatory mechanism in numerous places in the transport sector and represents either a constraint or an incentive depending on the net sum of the regulation in terms of the process of innovation. It is likely that the overordering of jumbo jets on the part of the airlines was induced to a significant degree by CAB rate-identity policies. Airframe and engine manufacturers were fully aware from historical precedent that advertisable differences are perhaps overly important to air carriers operating in such a regulatory environment because new and different aircraft attract substantially more patronage than is otherwise possible without price differentiation.

Another example might be one from a nonindustry-specific regulation such as that imposed by the Environmental Protection Agency (EPA). EPA establishes noise standards, often in concert with local authorities. These, in turn, have a significant effect on shaping the propensity of managements of carriers and their suppliers alike to embrace innovations. For example, engine manufacturers for both surface and air modes of transportation have devoted considerable resources to producing ever quieter power plants in response to the regulations and to the requirements imposed through political mechanisms by the general public.

Regulation will always provide a mixture of constraints and incentives to innovation in the transportation field, and the extent to which regulation is promotive or thwarting will change over time. The important point is that regulation is a major factor with respect to the implementation of intercity transportation innovations. This is so whether

those responsible for regulations are aware of it or not. Indeed, it can be anticipated that regulators will increasingly become aware of the relationship between economic and other forms of regulation on the one hand and technological change on the other. As the linkage becomes more clearly evident to the regulators, both the character of regulation and its application will improve significantly so as to minimize the unintended negative consequences of regulation as far as technological change and innovation are concerned.

Public Policy. Even more difficult to identify and to assess are the implications for innovation from public policy. The concept of public policy covers a great deal of territory. Among the more obvious and influential areas are those related to income distribution, land use, subsidy, and defense. In turn, public policies in each area can have a profound influence upon such an all-pervasive function as transportation. For example, if public policy toward subsidy is, in effect, to deny subsidy to private enterprise, the implications for innovation are very profound indeed. On the other hand, if subsidy as a matter of general policy is made available to a public-interest sector, such as transportation, on some formula basis (such as that related to rate of return on capital), then the implications for private transportation entrepreneurs are very different than in the previous example.

Since there will undoubtedly be constantly changing emphases in public policies, it is safe to predict that the implications for the implementation of intercity transportation innovations that flow from public policy will change over time. The net effect of changes in public policy is impossible to determine with any degree of precision over the period of time covered by the present analysis. This does not mean that public policy issues should be ignored in terms of their impact on technological change and innovation but rather that there should be continued and sophisticated analysis of public policy issues that carry with them implications for the process of innovation in intercity transportation.

Labor. Labor was earlier considered as a potential resource constraint on intercity transport innovation. Here, labor represents a source of social constraints and incentives to transport-sector entrepreneurs and their suppliers. The constraint represented by labor grows largely out of public policy which generally does not condone wholesale displacement of transport labor resulting from technological or organizational change. Labor must be cushioned against great discontinuities that would wipe out massive numbers of jobs. Employment in transport must be maintained at some given, substantial level, at least over the short term.

Labor contracts and public policy combine to represent a severe constraint to certain kinds of innovative activity in the transportation field. On the other hand, as transport labor becomes increasingly expensive, wherever it is possible to reduce reliance on labor through

the substitution of capital-intensive technology, management will tend to take advantage of the opportunity. In the latter case, of course, labor represents an incentive to innovate. By and large, however, labor is more a constraint on technological innovation in intercity transportation than it is an incentive, and it can be expected to remain so throughout the period covered by this analysis.

Interaction Between Resource and Social Constraints. The accompanying matrix (Table III-1) points out the likely influences on transportation innovation as a result of interactions between resource constraints and social constraints. Unfortunately, it is not always possible to determine even the direction of the influence of a social constraint on a resource constraint without knowing in greater detail the nature of each. Nevertheless, such a matrix is useful in framing the questions that need to be considered whenever any given specific constraint is to be analyzed in terms of others.

For example, consider the first column in the matrix, "Economic Regulation." It is impossible to say what impact the imposition of economic regulations will have on the pool of technology available for exploitation in the form of innovation without specifying what sort of economic regulation is involved. The implications of an economic regulation that permits a given intercity carrier to achieve a minimum specific rate of return on invested capital are quite different from those of a regulation establishing rigid floors under the rates to be charged for intercity transportation service. In the former case, the question mark found in cell 1B of the matrix would probably be changed to a plus sign as would cells 1C and 1D as well. Under such circumstances, 1E would very likely become a minus sign. For minimum rate regulation, on the other hand, it would be impossible to determine the effect on cell 1A without knowing a good deal more about the method of applying such regulations. Further, it is likely that 1C, and perhaps 1E, would be positive provided the industry was one where the previous lack of minimum rate regulation had placed its financial viability in jeopardy.

In the case of column 3, "Nonindustry-Specific Regulation," if the regulation in question imposed severe penalties on a carrier or industry for failure to meet some rigorous environmental standard, it is quite likely that the regulation would induce substantial R&D activity both in the public and private sector. This would convert the question mark in cell 3A to a plus sign. It is also possible that 3B would become an even "stronger" plus and that 3C may also be converted from minus to plus, although this is not nearly as clear. The effects on the availability of land might well be converted to a negative sign in cell 3F if the environmental regulations hypothesized were of a certain sort.

Table III-1

LIKELY INFLUENCE ON TRANSPORT INNOVATION OF INTERACTIONS BETWEEN RESOURCE AND SOCIAL CONSTRAINTS

	Social Constraints						
Resource Constraints	(1) Economic Regulation	(2) Antitrust Regulation	(3) Nonindustry-Specific Regulation	(4) Land Use Policy	(5) Subsidy Policy	(6) Defense Considerations	(7) Income Distribution Goals
(A) Technology	?	(+)	?	+	+	(+)	o
(B) Public $	?	o	+	+	+	(+)	(+)
(C) Private $	?	-	-	+	(+)	?	(-)
(D) Labor	-	o	o	o	+	?	(+)
(E) Management	?	(-)	-	-	(+)	?	(-)
(F) Land	o	o	?	?	?	o	?

Key:
+ Considerable supportive interaction.
o No likely interaction.
- Considerable thwarting interaction.
? Influence dependent upon specific case.
() Potentially influential as indicated.

High-Leverage Factors Influencing Transportation Innovation

As pointed out previously, there are a number of particularly influential factors that will affect the success or failure of transportation innovation. Many of these factors will determine whether an innovative process will begin at all, i.e., whether any measurable resources will be devoted to a given innovative process. Among the myriad factors that influence intercity transport innovation, eight can be singled out for consideration as among the most important and highly leveraged. These eight factors are:

1. Government as promoter of transportation
2. Maintaining "balance" in the transportation sector
3. Market aggregation
4. Purchasing philosophy and techniques
5. Test facilities
6. Foreign technology
7. Appreciation of innovation as a process
8. Innovative propensities

Government as Promoter. In virtually every age, each level of government is more or less active as a promoter of transportation enterprise. History therefore provides us with every reason to believe that governments will continue to promote transportation activities in various forms over the next half century and more. The role of promoter is manifest in many ways. For example, regulation that protects one carrier or one mode of transportation from another clearly promoted the activities of the protected carrier or mode. The certificate of public convenience and necessity which regulatory authorities issue under many circumstances is a device that is both promotive and restrictive.

Less subtly, government promotes transport activity through the device of subsidy. When public funds are made available to provide infrastructure in the highway and aviation modes to a greater extent than is recaptured through user charges, such funds represent a promotional subsidy to those modes of transportation. Government also promotes transportation activity--and specifically innovation in the transport sector--by funding research and development activity directly related to transportation. Federal support for the SST development program and for the high-speed ground program are cases in point. Such activities are sponsored primarily at the federal level, but state and local governments have also been known to provide funds for R&D work in areas of specific concern to them.

Government also provides operating subsidies to carriers at various times, again a clearly promotional device. Among the most obvious examples of such promotional efforts on the part of the government are the grants to local service airlines and the "operating differential subsidies" provided by the Maritime Administration to qualifying ship operators. The Urban Mass Transportation Administration (UMTA) mass transit operating subsidy is yet another bold example.

In promoting intercity transportation in general, and innovation in particular, government can distort the process of innovation and the relative pace of development among the various modes and methods of transportation by providing more resources and support to one mode or method than to others. It is undoubtedly true, for example, that the federal government has been far more direct in its promotional support for competing modes of transportation than it has for the railroads. No one can doubt that this has made a substantial difference in the innovative propensities and performance in the railroad field over the last 50 years.

Perhaps one of the most important issues in the future for intercity transportation innovations is whether the government will become cognizant of its potential as a promotive force and whether it will use its leverage to serve the explicit ends of public policy.

Balance in Transportation. Balance in the transportation field is given increasing attention, at least in the public pronouncements of politicians and in the preambles to legislation associated with transport regulation and promotion activites. The term "balance" in this context refers to the existence of alternative transportation modes. A balanced transportation system is one that is responsive to all the needs of the traveling and shipping public while providing them with a choice of mode and method wherever possible. It is achieved through coordinated allocation of public and private funds.

This concept of balance is important in the context of intercity transportation innovation. The degree to which it is achieved will significantly affect the innovative performance of both transportation carriers and their suppliers. Any perception of imbalance can lead to the direct or indirect allocation of resources to one mode as compared to others in order to cure the perceived imbalance.

But there are other dimensions of balance that have an even more profound effect on transportation innovation. For example, there is the issue of balance between infrastructural investment and equipment investment. Very little attention has been paid to this problem in two major modes of transportation: rail and air. As a result, a substantial imbalance has developed. In the former case, there has been too much equipment investment and too little infrastructural investment; in the latter, the opposite turns out to be the case. To the extent that these imbalances are recognized either by public sector or private

sector decision-makers, they can substantially influence the allocation of resources to and within the transportation field.

Another aspect of imbalance has already been referred to briefly: namely, the emphasis that is being placed on developments and R&D projects associated with exotic and headline-worthy technology in contrast to projects and technology that are less exciting though nonetheless critically important. Tracked air-cushion vehicles may be promising and even important, but this and similar technology should not be developed at the expense of less exciting transport systems or components that can be developed more quickly and have a useful payoff. Numerous technological possibilities may be crying out for exploitation in a transport context while many individuals and entities focus their attention many decades ahead and continue to develop exotic transportation technological possibilities. Balance is clearly required to assure that on the way to the far future the nation does not forego the opportunities for improving efficiency and productivity that are available to use in a far shorter time.

The final example of balance with respect to the transport sector concerns the relative emphasis on cost-reducing innovation versus demand-stimulating innovation. While frequently a single innovation produces both cost-reducing and demand-stimulating results (the Boeing 707 was an excellent example), it is also true that many innovations convey only one of the two benefits. By and large, where there is comprehensive regulation in transportation, such as that found in railroading in the United States, the emphasis of carriers and suppliers is necessarily on cost-reducing innovation. Under such circumstances, other things remaining equal, the greatest returns on investment in innovation accrue when costs are reduced but rates are not. When a cost-reducing innovation is also demand-stimulating, this situation is substantially modified, provided that the demand function is quite elastic and the regulatory agency permits the reduced cost to be reflected directly in lower rates. But transport regulatory agencies do not often permit cost reductions achieved through innovation to be reflected in rate reductions in a timely manner, thus placing great stress once more on cost-reducing rather than on demand-stimulating innovations.

If the United States is to breathe life into public policies supporting energy conservation, environmental pollution reduction, and other quite general objectives, it will be necessary for government, either directly or indirectly, to induce technological changes that often are demand-stimulating even when they are not cost-reducing. For instance, government may find it desirable to encourage the diversion of passengers and freight from one given mode or method of transportation to another. Certainly the future will see a change in the balance between cost-reducing and demand-stimulating innovation, and it will also likely see a continual shifting in emphasis between the two forms of innovation as a result of changing national policies and priorities.

Market Aggregation. Another high-leverage factor is market aggregation, which may be carried out with or without the intercession of government. Basically, market aggregation refers to the willingness and ability of buyers (in this case, carriers) to collectively define their needs and to pool their purchasing power in order to induce suppliers to provide a higher quality or more efficient product or service.

Market aggregation often requires the intervention of third parties. For instance, the Association of American Railroads (AAR) sometimes causes member railroads to define their requirements in a uniform manner so as to promote the development and implementation of a given technology or methodology. The development and introduction of automatic car identification (ACI) is a specific example of AAR efforts along these lines. Again, while AMTRAK was not explicitly set up to aggregate the market for railway passenger equipment, the essential monopolization of intercity rail transportation by AMTRAK has led to that aggregation and is having a growing effect on the nature and direction of innovation in the railway passenger equipment field.

Still in the context of railroads, it is almost certain that the reorganization of the Northeast railroads will create a quasi-governmental entity (ConRail) that will have substantial market aggregating powers. Such power can conceivably extend far beyond the boundaries of ConRail itself. ConRail will become the most influential single entity in the railroad industry and will be able to influence the demand for railway equipment in such a way as to have an impact on all rail carriers.

Market aggregation is especially difficult in cases where there are substantial numbers of independent purchasers of infrastructural components or equipment. Highway transportation is a case in point. Obviously, there is a horde of automobile buyers and the demand for automobiles is not significantly aggregated even by the existence of very large automobile rental companies and by government agencies that purchase significant numbers of automotive units. Similarly, there is a sufficient number of trucking companies to make market aggregation in any formal sense difficult, if not illegal. A market aggregation effect is achieved, however, by the federal government when it imposes standards upon the industry that cause technological innovations of various sorts to be emphasized in response to such regulations. Seat belt regulations immediately come to mind, as do standards for tires and truck braking systems.

The airlines fall in between the two extremes as far as market aggregation is concerned. By and large they are restricted by antitrust laws from colluding to the point of aggregating the market for aircraft or related equipment. On the other hand, the similarities in airline requirements induce aircraft manufacturers to serve as something of a market aggregating agent for their air carrier customers, albeit informally. Since aviation supply is a highly concentrated industry, it is doubtful that aggregation of demand could have a very profound effect on the process of innovation.

Of course, aggregation of demand almost by definition has some implications for any related process of innovation. Even though collective purchasing has the power to induce technological change, it may in other circumstances serve to discourage it. Certainly, the close-knit relationship between railroads and some of their suppliers has contributed to unnecessarily high concentration ratios in some sectors of the railway supply field. Although no formal agreement for collective purchasing exists, the relationships between carriers and suppliers are so strongly established that they virtually exclude entrance to the field. Obviously, the competitive pressures that induce innovative changes are lacking in this environment.

An example of how market aggregation encouraged beneficial innovation, and yet eliminated other innovations, can be found in the trolley industry. In 1928, the presidents of most of the streetcar and interurban operating companies met at the "President's Conference Committee" (PCC). In order to stave off the onslaught of highway urban transport, they agreed upon a standardized trolley vehicle that each would order. The standardization of design provided for substantial savings to the acquirers since the manufacturers were assured of large production runs of the design and were thus able to spread development costs over a great number of units. The "PCC car" sported innovations in the control system, steering, and trucks; however, few other car designs were produced for many years and little attempt was made at further basic improvements in trolley car design. The effect of this market aggregation was, first, to provide the operating companies with an efficient and dependable vehicle at a reasonable cost, but then to stifle innovation as time passed and other technological possibilities were not exploited.

Purchasing Philosophy. Certainly one of the most profoundly effective factors influencing intercity transport innovation relates to the purchasing philosophies and techniques employed by carriers and others involved in planning and producing the transportation the market requires. One of the philosophies of purchasing relates to market aggregation. Some entities involved in producing intercity transportation eschew all formal and/or informal means for aggregating the market for the inputs they require. Where this is done as a matter of philosophy or policy, obviously the effects on innovation are potentially substantial. On the other hand, many such entities desire to aggregate the market if only to assure similar cost structures to those of their competitors. Whether or not this motive is one that ought to be encouraged as a matter of public policy, it should be recognized that a purchasing philosophy that permits market aggregation to the maximum possible extent does not have a significantly different impact on the implementation of transportation innovations than one with the opposite bias.

Perhaps the most important single aspect of purchasing relates to the means by which transport enterprises acquire infrastructural components and equipment. If the purchasing philosophy is largely characterized by inertia (such as is generally true in the railroads in the United

States), then it is assured that there will be little technological change through innovation as the purchasing function concentrates on acquiring more of the same products and services from year to year. On the other hand, if the purchasing function is carried out pursuant to a philosophy that seeks the publication of true performance specifications, and if these performance specifications are revised and upgraded periodically to assure that the suppliers must continually reach out to the frontiers of technological possibility, then the purchasing function is greatly supportive of innovation in the transportation field. Indeed, it is to be hoped--even expected--that those in receipt of the increasing flow of federal funds into the transportation sector will be required to employ true performance specifications. These should include economic as well as physical parameters to assure that the greatest value is received for every dollar expended on infrastructure and equipment. It is difficult to imagine any single change having a more profoundly promotive influence on beneficial technological change and innovation in intercity transportation than the adoption by transport enterprises of a performance-specification approach to purchasing.

Foreign Technology. Foreign technology represents a particularly important potential spur to domestic technological innovation where transportation is concerned. The impact of foreign technology on transportation systems in the United States will be felt in several ways. First, to the extent that the transportation enterprises are not constrained to "buy America," the availability of foreign products embodying different and better technology should certainly induce American manufacturers to look to their laurels and to produce competitive or superior equipment employing more advanced technology than was previously the case.

In addition, the United States has become increasingly concerned with its balance of payments position and this could also induce domestic producers of transportation equipment to strive to exploit technological possibilities to the point where they have the most "exportable" possible product to offer in both domestic and overseas markets. The increasing inputs of public funds into the transportation field anticipated over the next half century will hopefully cause American producers of transportation goods and services to seek to maximize their foreign market opportunities. But it is also hoped that the injection of increasing public funds will not reduce still further the likelihood that American transport enterprises will avail themselves of foreign technology. History indicates that the latter is probably a forlorn hope since the infusion of public funds usually carries with it, either explicitly or implicitly, a number of "buy America" constraints. (The recent reaction of transportation labor in Pittsburgh to the possible operation of Boeing light rail vehicle [LRV] cars, which embody substantial Japanese inputs, certainly supports the latter hypothesis.)

Test Facilities. Coupled with the move toward performance-specification purchasing is the need for sophisticated test facilities to determine whether a supplier has, in fact, met the performance objective. Certainly, one of the drawbacks of technological innovation in the transportation field, particularly where intercity transportation is concerned, has been a general lack of many sorts of test facilities. Indeed, the Metroliner fiasco is, in part, testimony to what happens when a performance specification is developed without the ability to determine at an early stage whether or not the equipment involved meets the specified standard.

In this connection it is worth pointing out that the federal government has recently emphasized the provision of test facilities in the surface transportation field. Unfortunately, the stress has been on quite dramatic technology for the most part, and the United States still does not possess, for example, a facility capable of testing thoroughly such unglamorous equipment as railway freight cars and locomotives under all the conditions they will encounter throughout their service lives. Whether it is a private sector or a public sector function to provide such test facilities, they are clearly needed if the pace and direction of innovative activity in intercity transportation is to become what it can and should be.

Innovation as a Process. One of the substantial barriers to technological innovation in every field has proved to be the failure of those engaged in it to recognize that innovation is a *process*. The "better mousetrap" theory of enterprise has been thoroughly discredited for a long time. A firm can generate the very best of mousetraps in its research and development facility and even develop the means for producing them economically in quantity. But if they are not marketed skillfully against the competition, there will be no substantial innovation resulting from the creation of the better mousetrap. So it is essential in all fields of endeavor that those involved in each and every phase of the process of innovation must recognize the continuum of the process from conception through R&D, production, and finally to the marketplace.

Unless the process nature of this activity is recognized, innovation will be slower than it should be--and far more costly. In many instances, particularly in fields characterized by a complex production function such as transportation, the enterprises involved are not currently doing as well as they should simply because their managements do not recognize the process of innovation for what it is. Education related to innovation as a process, therefore, should pay very substantial dividends in terms of easing the path for the implementation of new technology where intercity transportation is concerned. A pivotal role in this respect can certainly be played by government, and with very minor expenditures of public resources. If government seizes the opportunity available to it to diffuse knowledge and understanding about the process of innovation in the transportation field, the innovative

performance of intercity carriers will be substantially better in the future than if government fails to take advantage of this opportunity.

Innovative Propensities. In large measure, the degree of innovative activity and results in the U.S. will be determined by a subtle factor sometimes referred to as the propensity to innovate. If society in general and transport-sector entrepreneurs (public and private) do not embrace technological innovation as a favored means to achieve the ends they seek, the likelihood of there being significant technological change in intercity transportation in the next 25 to 50 years is relatively small. Current widespread public disenchantment with technology would seem to suggest difficulties in the years to come.

On the other hand, it is difficult to see how the public in general and transport entrepreneurs in particular, as well as public officials concerned with transportation, can turn their backs on reality and history. After all, most of what is "good" about the public and private intercity transport network of the U.S. stems importantly from an evergreen technological base. Despite recent events, it is anticipated that, especially in a public service sector such as transportation, the propensity to innovate will once more become great. It is expected to first become apparent among operators; then among suppliers of hardware, software, and capital; and finally to be reflected in government policies.

Expectations for the Future

It is difficult to project the net effect of the various influences that will play on the process of innovation in the transportation field over the next 25 to 50 years. Only very general expectations can be advanced. Perhaps most important among these is that in the next 25 years, there will be no significant constraints to transport innovation as a result of a lack of technological possibilities. The constraints effective over the next 25 years are largely expected to be institutional and to relate to definitions and assumptions of responsibilities by various parties to the process of innovation in the complex transportation sector.

Between the years 2000 and 2025, it is quite likely that technological possibilities will be in short supply unless, at some point between now and the year 2000, substantial R&D activities are undertaken which will restock the vast inventory of technological possibilities presently in hand. These will be virtually depleted if any significant amount of technological innovation is introduced in intercity transportation over the next 25 years.

The implications of the above observations are generally quite obvious. In the near term, those involved with sponsoring research and development and those concerned with the implementation of R&D results should stress the institutional and "technology delivery" aspects of the

process of innovation in the transportation sector. Purely R&D projects should be specifically targeted to achieve a given result that by itself is deemed desirable based on quite precise calculations of the associated benefits and costs.

As the next quarter century unfolds, provided the technological possibilities now in the inventory are being exploited effectively and rapidly, it will be necessary once more to generate R&D results, some of which should certainly be on a speculative basis. In this manner, before the inventory of technological possibilities is substantially depleted it will be replenished as a result of the R&D activities undertaken beginning perhaps in about 1985 or 1990. If all goes well, by the turn of the century, it will probably be prudent for the United States once more to have a massive transportation-oriented R&D program which looks to the midterm and far future and which is speculative and hopeful at the same time.

Specific Innovation Scenarios. In order to determine the potential effect of various constraints upon intercity transportation, it is necessary first to postulate a social and economic climate for the country. The two crucial independent variables that influence this national climate are:

- The locus of regulation*
- The balance between competition and economies of scale favored by national policy

An additional variable, which is interrelated to these two, is represented by the underlying social climate and will be referred to here simply as "social awareness." A set of scenarios has been developed below to represent the extremes of each of these variables. The effects of the various constraints will be examined in the context of each scenario.

The *locus of regulation* refers to the sources from which the planning, funding, and implementation of regulation emanate. This locus can be either highly centralized on one extreme or highly decentralized on the other. Centralized regulatory authority tends to produce consistent and definitive regulation; however, it also tends to lack broad-based, multi-faceted appeal mechanisms. Decentralized regulation is apt to produce overlapping and layering of regulations, with great opportunities for judicial appeal and high potential for conflicting regulations. Such regulation also presents significant barriers to innovation because it

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*The present discussion should be read in the context of the companion paper, IX in this volume, which elaborates upon the concept of "locus of regulation."

makes the general environment anything but uniform and consumes great resources in pursuing decisions and awaiting policy formulation.

There is always a balance struck in the transportation industry between emphasis on competition and emphasis on benefiting from economies of scale. (The latter generally leads to oligopoly and monopoly.) A highly competitive transportation environment tends to produce smaller companies and usually results in lower real profits to the firm. Under these conditions, it is sometimes possible, however, for an extremely efficient company to evolve and be highly profitable. On the other hand, where realization of economies of scale is encouraged, the general result is a concentration of power in a few firms with the potential for the gathering of monopoly profits, unless there are other, offsetting regulatory constraints.

For present purposes, social awareness is characterized by the degree to which noneconomic issues such as concern for the environment, the interests of special interest groups, social equity, safety, and security are recognized and function as important constraints in the implementation process.

Eight scenarios result from the various possible combinations of the extremes of the three relevant variables: regulatory locus, competitive environment, and social awareness. The impact on economic and noneconomic forces affecting the implementation of a transportation system will be discussed for each scenario. Two scenarios, however, those combining monopoly and high social awareness, represent unlikely sets of conditions--unless, of course, nationalization is an admitted possibility.

It should be recognized that small perturbations in the overall national climate can produce substantial changes in one or more of the variables. Also, the situations analyzed in each of these scenarios represent extremes of behavior in light of the variables reviewed. Any movement away from the extremes of these variables will tend to produce a more moderate result.

A. Decentralized Regulatory Authority, Competitive Environment, and High Social Awareness. Under this scenario, the implementation of "grass roots" transportation systems is unlikely to succeed. The economic constraints on implementation will be severe due to the highly competitive environment that will result in low profit margins. The noneconomic constraints will present even more severe obstacles. Small, highly vocal, special interest groups will have virtual veto authority over new transportation projects. The regulatory lag* induced by the decentralized locus of regulatory authority and attendant uncertainties will tend to encourage firms with venture capital that would normally be used for transportation projects to look elsewhere.

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*Regulatory lag refers to the time lag from conception of a project until all of its regulatory requirements are fulfilled and the project completed.

There will be some opportunity for incremental growth of the existing transportation infrastructure, particularly where it can be demonstrated that greater social benefits will be obtained through this incremental growth than through the creation of a new infrastructure elsewhere. However, the relative freedom of entry and exit implied by the competitive orientation of regulatory planning would tend to encourage entrepreneurial activity. The diffused locus of regulatory authority will produce a situation whereby the delivery of governmental assistance to transportation firms will be difficult. The decentralization of regulation and, hence, planning will tend to divert funds away from substantial projects and into limited scope projects. Under these constraints, technological advancement will be low, as firms will be unwilling to invest due to the uncertainty of reward.

The implications for the nation as a whole are that significant large-scale intercity transportation projects will not be undertaken either by private enterprise or by government. Rather, transportation undertakings will take the form of incremental growth and improvement in existing facilities. From the standpoint of the firms, entrepreneurial activity in transportation will be confined to smaller firms and will be limited to projects not requiring extensive capital commitments on their part. There could be some emphasis on government-funded demonstration projects, but those would not likely be exploited by the private sector. Furthermore, there will be many opportunities for abuse by government officials and by small entrepreneurs. In general, this scenario produces a national transportation system that would be only a small improvement over what exists today. Nationalization would be an unlikely result of this scenario.

B. Decentralized Regulatory Authority, Monopolistic Environment, and High Social Awareness. This scenario contains a certain inconsistency because the variables are not independent. It is unlikely that with decentralized regulation and high social awareness that a high degree of monopoly power concentrated in private enterprise would be allowed to exist. Movement in the direction of such a scenario, however, would have the following implications. The likelihood of entrepreneurial behavior on the part of large firms would be increased under these conditions. Some firms would be willing to pay the price in terms of regulatory lag and meeting the peripheral regulatory constraints in exchange for the potential for very high or monopoly profits. Also, the potential for new technological development would be enhanced through this same mechanism. However, the mechanism for government funds delivery would continue to be fragmented, and as a result, technology and entrepreneurial activity would have to rely largely on private enterprise rather than governmental impetus.

The national transportation system that would evolve from this scenario would include privately financed incremental growth on existing systems combined with a few major projects funded through private investments. Some of these major projects would undoubtedly represent "grass roots"

technological development with some funding through government agencies. In this scenario, the potential for abuse by large firms and by government is significant. Some transport nationalization would be possible when the perceived social good outweighs regulatory/planning problems.

C. Decentralized Regulation, Competitive Environment, and Low Social Awareness. Under this set of conditions, government policy would undoubtedly be oriented toward preservation of competition under an "anti-bigness" banner. The regulatory authority would still tend to produce an extensive regulatory lag, although this lag would probably not be aggravated by the overlapping regulations from other fringe regulatory areas. Entrepreneurial activity and technology delivery will be limited to smaller firms with a resulting incremental, rather than quantum, growth.

Without a centralized locus of regulatory planning, there will be little federal involvement in the growth of transportation infrastructure for guided surface vehicles. This will be left largely in the hands of private enterprise and entrepreneurs. Technological developments would tend to be slow. Firms would lack the size and resources necessary to embark on massive R&D efforts. The potential for abuse by government and by small entrepreneurial firms is high. There would be little potential for monopoly abuse, however. Nationalization would not be a likely outgrowth of this scenario.

D. Decentralized Regulation, Monopolistic Environment, and Low Social Awareness. These conditions would tend to promote large monopolistic firms that would take advantage of the fragmentation of governmental regulation and the lack of limiting constraints from public interest advocates. The rate of technology delivery would probably be fairly high as firms recognize how to cope with the various levels of regulatory authority and use it to their advantage while continuing to reap high or even monopoly profits. Decentralization of regulatory authority will likely enhance the ability of the firms to reap such monopoly profits. Entrepreneurial (i.e., motivative) activity would probably be restricted to large firms, as only they would have the financial resources to support ventures of sufficient magnitude to reap the necessary economies of scale. The source of funding for entrepreneurial activity and technology delivery programs would be the large firms. The regulatory and planning agencies in the public sector would likely not have funding available to support innovative prospects of this type.

The transportation network that would evolve from this scenario would consist of a relatively small number of large multimodal firms controlling large geographic or economic areas of the transportation market. These firms would have the power to introduce new technology and to undertake large-scale projects, but whether they would have the incentive is difficult to predict. The multiplicity of regulatory authorities would

probably not produce strong pressures for developments in the public interest; consequently, there would be a tendency to retain the *status quo* technologically and otherwise. There would be extreme potential for abuse of monopoly power under this scenario, since regulatory authorities probably would be unable to or would lack the will to cope with the large firms. Nationalization would not be likely under this scenario; however, large nationalized firms created before this stage would do extremely well.

E. Centralized Regulation, Competitive Environment, and Great Social Awareness. Under such conditions, the transportation network would involve a fairly large number of small firms competing in the marketplace under a well-defined set of ground rules. The focus for developing technological possibilities and for promoting innovative activity would rest with the government which, through a strong centralized planning and funding agency, would attempt to mandate the most socially acceptable transportation networks. This would include considerations of convenience, environmental protection, public safety, and perhaps even some cost criteria. Under these circumstances social objectives would tend to take precedence over economic efficiency. Marginal firms would be kept afloat through subsidies of various types, and technology delivery would be greatly conditioned by government attitudes and policies. This scenario could support large-scale transportation development programs through massive federal involvement; in fact, emphasis would probably be on these at the expense of incremental growth scenarios. Nationalization would not be likely; however, subsidization of small, marginal firms to promote competition would be commonplace.

F. Centralized Regulatory Authority, Monopolistic Environment, and Great Social Awareness. Under this admittedly unlikely scenario, government would be the prime locus of entrepreneurial activity. However, technology delivery would be through subsidies/grants to large monopolistic enterprises which would each control great portions of the transportation industry. Monopoly firms with their ability to command large portions of the market would reap the available economies of scale and, therefore, have the capability of producing a relatively efficient transportation system provided the impetus were present. If these economies were passed on to their customers in the form of lower prices, if there were enlightened economic regulation through a strong centralized regulatory authority, and if a high degree of social consciousness existed, then an efficient, responsive transportation network, from the standpoint of social results and economic cost, would probably be produced. (Unfortunately, there is little encouragement from history that this combination of conditions is likely to be realized.)

G. Centralized Regulatory Authority, Competitive Environment, and Low Social Awareness. Here, the emphasis is on economic constraints

with an avowed government policy to encourage small firms. The locus of entrepreneurial activity would be the small firm, and the locus of technology delivery would be the federal government. Technological emphasis would be primarily on cost reduction or market extension. Economic constraints would tend to limit entrepreneurial activity. It is unlikely that large-scale "grass roots" programs for social purposes would be embarked upon. Of course, some small firms would be able to compete more effectively than others as they take advantage of the available technology to reduce their operating costs and improve profits. There would probably not be much potential for great abuse of the public interest under these constraints. It is also unlikely that the federal government would be deeply involved in subsidization. There would probably be a large number of turnovers among the small firms; therefore, entry/exit requirements would have to be fairly liberal.

H. Centralized Regulatory Authority, Monopolistic Environment, and Low Social Awareness. Under this set of conditions, large firms would be allowed to develop monopoly power over vast geographic or market segments of the transportation industry. Their principal constraint would be through economic regulation by the centralized regulatory authority. These firms would function much the way electrical utilities do today. There would be some research performed by the government, particularly in cost-reducing techniques. It is unlikely that the large firms would undertake significant research or innovations on their own as economic regulation and their monopoly power would ensure a satisfactory financial return; moreover, there would be little internal pressure to develop cost-reducing innovations. This scenario would undoubtedly produce the most *status quo* of transportation systems. Transport growth would undoubtedly take place only to serve established economic needs and demands, never to promote them. It is unlikely that the government would mandate cross-subsidization of marginal services in order to fulfill social purposes.

Concluding Remarks Concerning Scenarios. It should be clearly understood that the above scenarios have been drawn in terms of the extremes of the three underlying variables. None is intended to be descriptive or prescriptive of a future state of affairs in the U.S. The nature of governance in America tends to preclude extremes of the types described. The device has been used as a means for contrasting probable impacts of differences in those key forces that determine the economic and social context within which transportation investment decisions are made (or not made).

The current situation in United States transportation involves a mix of decentralized and centralized regulation, relatively high social awareness, and a somewhat mixed bag of competitive environments varying from virtual monopoly in certain parts of the railroad industry to a highly competitive environment (e.g., as exists in the barge and motor carrier industries). Scenario A comes closest to describing present conditions.

The current direction of movement is toward more centralization of regulation, increased social awareness, and a more competitive environment, i.e., toward Scenario E.

As long as economic recovery appears to be just around the corner and no major perturbation occurs in the economic climate, the regulatory, social and competitive factors will probably continue to move in their recent directions. The next economic decline, however, will undoubtedly cause sectors to change again, perhaps to an opposite position. It is conceivable that the next pendulum swing could move the transportation environment toward more decentralized regulation (probably with central policy control), lessened social awareness (and activism), and a more monopoly-oriented environment. This climate would be similar to that presented in Scenario C.

In the context of transportation system innovation and implementation, under present conditions it is likely that:

- There is relatively little incentive for private sector firms to undertake large or high-risk investments to develop innovative transportation systems.
- There will be a growing and vocal anti-automobile, pro-mass-transit constituency calling for increased government intervention and control.
- There is, however, very little real weakening in the basic strength and dominance of the private passenger car.
- While there have been a number of highly visible government demonstration projects, these do not appear to have catalyzed any significant new or greatly enlarged private sector commitment to transportation, either urban or intercity, passenger or freight.
- The enormous sunk cost of existing transportation systems in both vehicles and infrastructure will act as a large inertial component so that any significant near-term technological changes will be incremental in nature.
- The accumulated body of rules, procedures, standards, and established practice also tends to function as a conservative element to slow the rate of change and the pace of innovation.
- There is increasing resistance on a number of different socially oriented fronts which will effectively continue to combine to forestall, block, or otherwise thwart large-scale public investment projects relative to intercity transport.

IV. THE CONGRESSIONAL POLITICS OF TRANSPORTATION EXPENDITURE: IMPLICATIONS FOR THE FUTURE

by

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ABSTRACT

This paper explores the congressional politics of transportation expenditure. It concludes that congressional behavior in the field of transportation has been crisis-oriented and pressure-responsive.

More importantly, it concludes that this pattern of behavior serves to limit the policy and technology options that are admissible candidates for federal funding. It argues that the recurrent political motifs of congressional behavior can be used as evaluation criteria to compare the "political viability" and consequent implementability of transportation improvements requiring federal funds.

Congressional support for transportation expenditures has historically occurred:

1. *When public investment delivers benefits--jobs and service--is a significant fraction of the nation's congressional districts.*

2. *When spending proposals balance the interests of urban, suburban, and rural constituencies and reflect the changing balance of power between rural and metropolitan areas.*

3. *When operating assistance is necessary to sustain existing service. De nouveau operating subsidies are contrary to congressional predilection.*

4. *When expenditure levels can be established incrementally and system development accomplished in evolutionary stages.*

5. *When expenditures reinforce the partnership between the public and private sectors.*

The pattern of congressional behavior suggests the outlines of a "political viability and admissability" test for use in evaluating research and development (R&D) priorities. The test is stated as a series of questions:

1. Can the system eventually operate at or near a profit?

2. Is the technology adaptable to both large- and small-city market? Urban and suburban?

3. Are front-end costs sufficiently large that rural/metropolitan consensus is necessary for expenditure approval?

4. Can the system be implemented and operated in phased segments?

5. Would the system pose a significant competitive threat to other transport modes--particularly those in private ownership?

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These questions provide politically seasoned evaluation criteria against which next generation technologies can be assessed, but they should not be used rigorously as "necessary and sufficient conditions" of congressional support. Rather, the criteria should be used to *compare* the political viability of competing policy and technology options. The issue paper applies the criteria to an assessment of the "political acceptability" of high-speed ground transportation (HSGT), airport expansion, and increased bus service.

HSGT would require substantial operating assistance to compete with air transportation. As a result, it seems likely to meet with congressional reluctance to approve *de nouveau* operating subsidies. Its immense front-end construction costs should provoke considerable resistance from rural interests and fiscal conservatives. The infrequency of proposed stations for corridor service may undercut support within megalopolitan corridors where substantial right-of-way condemnation and community disruption would be inevitable. In short, HSGT lacks a needed urban/suburban/rural consensus for major congressional expenditures. Additionally, only one or two corridors have the necessary traffic densities to justify the front-end capital investment, and HSGT market penetration in those corridors would be viewed as a significant threat to private airline profitability. And HSGT's need for "whole system" implementation (including new guideways and right-of-way) runs counter to the congressional penchant for incremental funding of evolutionary technologies.

In contrast, airport and bus fleet expansion are incremental strategies with substantial flexibility of application. They are prone to evolutionary development in terms of both funding level and phased implementation. Both air and bus vehicle technologies are amenable to market differentiation strategies for both large and small markets and high- and low-density routes.

Judged against the criterion of congressional salability, evolutionary technological and operational improvements in intercity bus and air transportation offer R&D opportunities that are significantly superior to those of HSGT.

IV. THE CONGRESSIONAL POLITICS OF TRANSPORTATION EXPENDITURE: IMPLICATIONS FOR THE FUTURE

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IV. THE CONGRESSIONAL POLITICS OF TRANSPORTATION EXPENDITURE: IMPLICATIONS FOR THE FUTURE

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Introduction

This issue paper explores the congressional politics of federal expenditure for transport infrastructure and operations. Three case histories of congressional decision-making--the highway trust fund, mass transit operating assistance, and the formation of AMTRAK--are presented in an effort to generate hypotheses about the likelihood of federal assistance for next-generation ground transport systems.

The hypotheses are stated as generalizations about recurrent patterns of political behavior that seem to describe the preconditions of congressional support for the large-scale investment that would be required to implement high-speed ground transportation.

The three case studies are narrative in format and are presented in two case histories in the appendixes. The authors' hypotheses about the dynamics of the appropriations process follow. These hypotheses are then related to the likelihood of congressional appropriations for next-generation passenger rail services in the Boston-Washington and San Francisco-San Diego corridors.

The Political Economy of Federal Transport Policy

Congressional support for transportation has emerged and evolved in a manner that must be described as incremental, remedial, and piecemeal. The appropriations process does not seem to have been guided by "comprehensive, coordinated, and continuous" planning or by coherent national policy objectives. Instead, congressional policy-making has been reactive. It conforms to the crisis-oriented, pressure-responsive model of political decision-making that political pluralists have dubbed "the science of muddling through."

The zig-zag path of national transportation policy does, however, display certain recurrent political motifs. It seems reasonable to expect that the structural and behavioral dynamics of the congressional appropriations process will continue--select-committee budgeteering and the dismantling of the seniority system notwithstanding.

The case histories offered in the appendix suggest the following hypotheses about congressional expenditure for transportation:

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1. Substantial federal investment in transport infrastructure is unlikely unless project implementation delivers benefits--jobs and service--to a significant fraction of the nation's congressional districts. Proponents of the Highway Trust Fund were able to argue that the Interstate System "touches or crosses 406 of the 435 Congressional Districts." Proponents of mass transit operating assistance were able to demonstrate that publicly owned transit was receiving local subsidy in more than 235 congressional districts (in most cases from onerous property taxes). The AMTRAK concept captured support by adding routes in the Southwest and Pacific Northwest. AMTRAK proponents argued that the legislations would guarantee train service for 90% of the 122 million people in cities of 50,000 or more.

2. Federal transport spending is conditioned by the balance of power between urban, suburban, and rural constituencies. "Probably the most significant trend apparent (in federal transport appropriations) is the shift of expenditures from 56.4 percent rural areas in 1957 to 57.2 percent SMSA in 1971" (DOT-p. vii). This shift in expenditure reflects the urbanization of American society during the 1950s and 1960s; it does not mean that expenditures in rural areas declined but rather that the rural *share* of federal spending declined *relative* to metropolitan areas. The case studies indicate that rural interests must still be satisfied or neutralized to win approval for major expenditures.

   To avoid threatening rural interests, proponents of Highway Trust Fund diversion explicitly limited discretionary funds to those on the Federal Aid *Urban* System. The Highway Trust Fund itself can be viewed as an urban buy-in to a Federal Aid Highway Program that had previously been rural in emphasis: vehicle miles logged by intraurban commuters were used, in effect, to "cross-subsidize" the construction of the intercity links of the Interstate System.

   The approval of mass transit operating assistance reflects a similar balancing of urban, suburban, and rural interests. Subsidy proponents sacrificed an incentive-based allocation formula (8 cents per passenger) to win support from West Coast congressmen. The National Mass Transportation Assistance Act, as finally approved, delivers operating assistance on the basis of population and population density rather than transit output. The approved strategy spreads subsidy benefits to suburban and small urban areas. Operating subsidy proponents saw suburban and small-city support as crucial ingredients in legislative approval.

   The *National Journal* reported their success this way:

   > "All other major urban development programs have run afoul of racial and social controversies--low-income housing, for example, which is viewed by suburban politicians as a threat to social harmony, not as an

economic blessing. These (other) programs have a confined center-city constituency, and thus are fated to grow slowly, if at all.

"But mass transit is attractive to entire metropolitan areas. Suburban residents want money spent on transit to improve commuter service, and downtown business interests regard mass transit systems as the catalyst needed to trigger economic revival in the urban centers."

The congressional debate over AMTRAK reflects a similar balancing process with high-density routes, in effect, subsidizing small-city service.

3. Operating subsidies have not resulted from a congressional inclination to view transportation as a "central merit good" or from a desire to capture external social and environmental benefits that cannot be priced through fares. Rather, operating subsidies have resulted from the need to "bail out" and sustain services that were once profitable. Opponents of operating assistance--the Nixonian Office of Management and Budget (OMB), nonurban Republicans, many transportation economists--argued that operating assistance is "a bottomless pit" and "a subsidy for inefficiency." New Jersey Senator Harrison Williams was apparently more persuasive:

"All of these arguments have truth in them; none are (sic) red herrings, least of all the bottomless pit argument. But none of them accept my first conclusion--that we have to keep mass transit going, that we can't have it go down, and then farther down, and then eventually out.

"We can't let anyone exploit some disincentive argument, no matter how worthy, to defeat the ultimate objective--the preservation and improvement of mass transit."

The same argument prevailed in the formation of AMTRAK: Congress swallowed hard and accepted subsidy as the price that must be paid to prevent discontinued service.

Congressional reluctance to approve operating assistance--and to even use the language of "subsidy"--argues powerfully that operating assistance is politically viable only when well-established services with nationwide benefit zones fail the farebox test after a history of profitability. *De nouveau* operating subsidies seem unlikely at best.

Congressional resistance to operating subsidies is only partially attributable to its predilection for economic efficiency and

pay-as-you-go user financing. It is also rooted in a tradition of public-works expenditure that has emphasized capital grants to "build solutions." Capital grants have congressional appeal for a number of reasons: they involve one-time expenditures; they create jobs and enhance "community pride"; they can be manipulated to fit macroeconomic strategies for economic stimulation; they minimize the "locked-in" budget requirements of operating agencies like the Department of Defense; they are consistent with the "Old Federalism" of categorical expenditure.

4. Congress establishes expenditure levels incrementally--a practice that discourages "whole system" or "next generation" solutions that are not amenable to phased implementation or evolutionary development.

Senator Williams described his strategy for winning approval for transit operating subsidies in terms of tactical incrementalism: "We figured our strategy in 1972 would be to open the door with a soft one, some kind of strategy that would look like a backward step but really wouldn't be." The *National Journal* commented that "the approach is designed to promote the appearance that the operating subsidies do not constitute a new program."

The Northeast Corridor metroliner and turbo-train are "solutions" in the evolutionary tradition and AMTRAK appropriations have displayed a similar pattern of gradual commitment: from $100 million in loan guarantees in 1971 to $150 million in 1972, and $400 million in 1974. AMTRAK capitalization was initiated with at least faint hope that a one-time infusion of funds would restore the service to profitability. Funding levels have continued to increase despite the evaporation of those hopes.

The Interstate Highway System represents Congress' closest approximation of a "whole-system" approach to transportation development. President Eisenhower called the Trust Fund a "'grand plan' for the rebuilding of our obsolete road and street system . . . over a 13-year period.' But even the Highway Trust Fund should be viewed as an incremental financing strategy--despite its ambitious objective and its substantial size.

In approving the Trust Fund, Congress rejected bond financing of the Interstate System--the "whole system" solution. Instead, it opted for pay-as-you-go user financing from gas tax revenues. Travel--some considerable portion induced by freeway availability and suburbanization--financed interstate construction at a rate that increased from $1.0 billion in 1957 to $2.2 billion by 1960. From 1965 to 1975, federal Trust Fund outlays increased from $4.0 billion to $4.6 billion.

5. Congressional appropriations for transportation have reinforced the partnership between the public and private sectors with highway

spending leading to domino-like expenditures to preserve passenger rail and mass transit.

There is no indication that federal expenditures were intended to create competition between publicly and privately operated transportation; and considerable evidence from the Trust Fund diversion case exists to show that private sector resistance to overt competition--for extra funds or passenger revenues--might well be sufficient to deter public intervention.

The Implications of Congressional Behavior

The patterns of congressional behavior sketched above provide a test which can be applied to the likelihood of large-scale investment in next generation technologies such as high-speed ground transportation.

That test can be stated as a series of questions:

1. Can the system eventually operate at or near a profit?

2. Is the technology adaptable to both large- and small-city markets? Urban and suburban?

3. Are front-end costs sufficiently large that rural/metropolitan political consensus is necessary for expenditure approval?

4. Can the system be implemented and operated in phased segments?

5. Would the system pose a significant competitive threat to transport modes--particularly those in private ownership?

These questions provide politically seasoned evaluation criteria against which next generation technologies can be assessed. They are obviously not so rigorous as to merit description as "necessary and sufficient conditions of transport development." Nor does a technology's failure to "pass" any given question indicate that it should be disqualified from serious consideration as a candidate for future implementation. They do, however, begin to provide a reasonable handle on the comparative likelihood of congressional appropriation for the implementation of various candidate technologies.

Applying these criteria comparatively to assess the political viability of federal spending for high-speed ground transportation (HSGT), airport expansion and increased bus service seems to produce fairly conclusive results.

High-Speed Ground Transportation. Current estimates indicate that HSGT would probably require substantial operating assistance to offer

fares that are competitive with air transportation. The case histories indicate congressional reluctance to approve *de nouveau* operating subsidies.

Cost-per-mile estimates for HSGT construction on the order of $10 million per mile suggest that the system will involve immense front-end costs. These costs seem sufficiently substantial to provoke considerable resistance from rural transportation interests and fiscal conservatives. At the same time, the infrequency of stations proposed for corridor service may deprive the system of consensus support even within megalopolitan corridors where substantial right-of-way condemnation and community disruption would be inevitable. As a hub-to-hub fixed-guideway system it seems unlikely the HSGT can develop the urban/suburban/rural consensus which seems to be necessary for major congressional expenditures.

The system also has the liability of narrow application. Traffic densities on the order of 20 million passengers per year appear necessary to justify the front-end capital investment. Population densities necessary to support this kind of traffic volume are limited to one or perhaps two corridors on the continent. A system achieving a market penetration of 20 million passengers per year would most probably be viewed as a significant threat to private airline profitability in those corridors--a justification for private investment but a considerable liability for public capitalization.

"Whole-system" implementation (including new guideways and right-of-way) seems to be required for HSGT--another significant liability given the congressional penchant for incremental funding of evolutionary technologies. It seems doubtful that Congress would appropriate the front money to build a system that will remain inoperational through the multiyear construction effort probably necessary to link major city-pairs.

Bus and Conventional Air. In contrast, airport and bus fleet expansion are incremental strategies with substantial flexibility of application. They are prone to evolutionary development in terms of both funding level and phased implementation. Both air and bus vehicle technologies are amenable to market differentiation strategies that suit them to both large and small markets and to high- and low-density routes.

Judged against the criterion of congressional salability, evolutionary technological and operational improvements in intercity bus and air transportation offer research and technology (R&T) development opportunities that are significantly superior to those of high-speed ground transportation.

Appendix A

CASE HISTORY NO. 1: HIGHWAY AND TRANSIT FINANCE

Appendix A

CASE HISTORY NO. 1: HIGHWAY AND TRANSIT FINANCE

The Highway Program

Federal spending for highway construction began with and has retained strong rural support in Congress. The first federal aid for roads in 1916 was stimulated by a coalition of farmers, state legislators, and railroads interested in getting produce to rail heads. Urban areas were specifically excluded from the legislation. Federal aid to urban areas was added gradually but haphazardly before World War II. The Federal Aid Highway Act of 1944, which called for large-scale postwar investment in the neglected highway system, provided regular federal aid for urban roads for the first time, along with larger amounts for rural primary and secondary highways. The Act also approved the concept of the Interstate System, but rural legislators wary of any drain on funds for primary and secondary roads prevented appropriations for the System.

Little progress was made on the Interstate until the loose alliance of interests that had grown up around federal support for the ABC system--the automobile, petroleum, trucking and contracting industries, real estate interests, and state and federal highway officials--began pressing in the early 1950s for funding of the System. President Eisenhower, intrigued by the possibilities of the network for aiding national defense, lent active support and set up an advisory committee headed by Retired General Lucius Clay. The committee recommended that the federal highway program be administered by a Federal Highway Corporation empowered to issue bonds to finance construction of the Interstate.

There was little congressional opposition to the Interstate concept. The System offered clear benefits--convenience, safety, and stimulus to the economy--and threatened no apparent harm. State governors were enthusiastic about a new infusion of federal money with a 10% matching requirement. Though the System was originally conceived and still presented as a network of long-haul linkages of cities that would not actually penetrate urban areas, in its final form the proposal called for urban construction, and mayors and other urban interests supported it. The social and environmental impact of urban highway construction--air pollution, neighborhood disruption, etc.--were not yet salient issues and were not raised in the congressional debate.

Congress reflected this unanimity. Along with benefits on a national scale, the Interstate would provide jobs and transportation capacity in nearly every congressional district in the country. Rural and urban representatives alike saw constituency appeal in the program.

The only sticky point was financing the new system. Congressional conservatives objected to the advisory committee's proposal for issuance of bonds as fiscally unsound. After considerable discussion, the Highway

Trust Fund emerged as a compromise. Revenues from taxes on gasoline and sale of trucks, use of highways by heavy vehicles, and tires and other items would go into a special fund earmarked for construction of the Interstate and, to the extent money was left over, the ABC system. This pay-as-you-go, user financing arrangement had already been used successfully at the state level by highway departments to insulate their funding and insure its continuity. The adoption of Trust Fund financing mollified conservatives and won support from highway interests, who applauded its exemption from the yearly appropriations struggle, its open-endedness, and its status as a federal "promise" to build highways. Though the point was raised that a disproportionately large share of the Fund's income would be generated by urban commuters making local trips, the urban contingent in Congress did not object as rural legislators would later object to paying urban transit costs.

After its inception in 1956, the Fund acquired a nearly sacrosanct status in Congress. The complex of interests with a stake in the highway program occupies a large and central place in the nation's economy, and has been estimated to employ one in every five of its workers. Construction, paving, petroleum, and auto interests, allied with state and federal highway officials in an array of trade associations, "user" groups, and informal associations, created a vocal, well-financed, and relatively coherent lobby whose influence rivaled that of the defense lobby. The highway lobby courted key members of the House and Senate Public Works Committees and their Roads Subcommittees, which have jurisdiction over the federal highway program, receiving overwhelming support from these rural-dominated committees. The road program assumed a preferred status in the Congress; completion of the Interstate was a "national commitment" and the Trust Fund was to be preserved against any nonhighway use. At the height of its strength, this combination of highway interests and congressional support could twice force President Johnson to back down from deferring expenditure of a fraction of the total 1967 and 1968 highway funds, measures badly needed to cool inflation.

Thus insulated, the federal highway program grew. From an initial mileage of 37,600 and cost estimate of $27 billion, the Interstate has been repeatedly expanded and refunded. The completed System will exceed 42,500 miles, $100 billion, and its completion date has been extended past 1980.

The Transit Program

Urban mass transit declined precipitously during the 1950s and 1960s--a casualty of auto-mobility, suburbanization, the highway program, and local political fragmentation. Despite increasing frequent bankruptcy among privately owned transit properties, there was little effort to involve the federal government in the transit problem during the 1950s. Many urban interests were still focused on highway development, which already had federal support, and the failure of privately owned transit companies was only beginning to foist responsibility for urban

transportation on local governments. Many commuter rail lines were in financial trouble, but the railroads pressed only for approval to discontinue commute runs.

In 1958, Congress responded to the railroad pressure by amending the Interstate Commerce Act to allow the Interstate Commerce Commission to permit quick discontinuances that would otherwise take years to get from reluctant state regulatory agencies. The result was a sharp increase in abandonment of unprofitable runs, and many large cities lost or felt threatened with the loss of commuter service.

Several Eastern city mayors and railroads tested congressional interest in commute transit but got little response. Urban problems had not yet been established as a legitimate subject for congressional concern, and urban transportation problems were viewed as a local problem. If transit operations failed, the solution was better management at the local level; federal rescue was inappropriate. The initial effort to get federal help, however, did serve to attract local interest in the problem, and a loose coalition of urban Democrats, downtown economic interests, newspapers, labor groups, commuter railroads, and transit operators began to form around the problem.

In 1960, Senator Harrison Williams, a freshman New Jersey Democrat and early urbanist, took up the urban transit cause. Williams broadened the transit aid program pushed by the nascent transit coalition from a reaction to the loss of commuter service to a response to all urban transit problems. Presentation of the program as an *urban* rather than a *transportation* measure allowed Williams to cultivate it in the Commitee on Banking and Currency--which had jurisdiction over the sketchy federal urban programs and of which Williams was a member--rather than sending it through the more hostile Commerce Committee. Congressional support for the program was still inadequate, however, and an effort in 1960 to get federal loans and demonstration grants failed.

Though President Kennedy saw the need for a federal role in urban problems and campaigned on the issue, he offered no support for Williams' next legislative attempt in 1961--again calling for federal loans and demonstration grants. Congress was still not prepared to pass transit aid legislation as an independent package, and the loan and demonstration grant measure was eventually passed as part of the omnibus housing act of 1961. The Housing and Home Finance Agency, the federal government's closest approximation of an urban affairs agency, was given control of the program. It had authority to loan $17.5 million for mass transit projects where repayment was reasonably certain. It could grant $25 million for demonstration projects where upgraded transit systems could attract ridership from the automobile.

Williams' next step was to get outright capital improvement grants for transit systems. President Kennedy finally endorsed federal aid in the form of capital grants in 1962. But opposition from rural conservatives and the failure of the protransit forces to enlist the full support of

labor and mount a forceful campaign for the legislation stalled capital grant legislation in 1962.

Williams tried again in 1963 and got Senate approval but had to bottle up the bill--seen as a big city Democratic measure--in a House committee to avoid the wrath of Southern conservatives at President Johnson's civil rights programs. In 1964, a new pressure group representing central-city interests, the transit industry, and the railroads managed to win labor fully to its side by promising a job protection clause in the legislation. Labor endorsement brought administration support, and the transit forces risked a floor vote for the stalled legislation. An unusual departure of Northern urban Republicans from the party line on transit was sufficient to offset the loss of conservative Southern Democrats, and the Urban Mass Transportation Act of 1964 was enacted. The measure continued the existing loan and demonstration grant programs and added capital grants. Funding was authorized at $150 million per year for three years.

As federal intervention in urban problems gained legitimacy and a new cabinet level department was formed to deal with those problems, Congress accepted the legitimacy of transit's claim to capital assistance and began to address the scale on which it would be granted. Federal subsidies to pay for transit systems' operating losses, however, had not been established as legitimate. Federal money could be used to renovate existing systems and build new ones, but they still had to pay for themselves or recover operating deficits from local taxes.

In 1966, Senator Williams introduced amendments to the 1964 Act to add new training, planning, and research programs and to increase the level of funding to $225 million per year. A move to include money for operating subsidies was cut in committee. The new programs survived, but conservatives managed to keep spending in the final legislation at the 1964 level for the ensuing three years. Federal aid to urban transportation had gained a foothold in Congress in the space of a decade, but the size of the federal effort was dwarfed by the massive federal commitment to highway construction.

Competition Between Highways and Urban Transit

During the 1960s, the adverse impacts of highway construction became increasingly apparent in urban areas. Widespread resistance from an array of urban interests stalled construction in many cities.

During the same period, urban transit systems fell into accelerated declines. Inflation forced many private operators with the vicious cycle of rising fares, declining patronage, and abandoned routes. The burden of operating deteriorating systems fell to underfinanced city governments in more and more cities.

These developments lent new force to the persistent but unpopular view that federal aid for urban transportation was badly imbalanced in favor of highway construction at the expense of mass transit. Thus, as the 1960s wore on, it became impossible to deal with federal aid to each of the modes independently of aid to the other; support for one program necessarily implied some kind of position on the other. For those who favored greater balance and more local discretions, several alternatives were possible. The most extreme was to eliminate the Highway Trust Fund entirely and subject the federal highway program to the regular budgetary process. A less drastic alternative was to leave the Fund in existence but divert some of its money to highway and nonhighway mass transit purposes. A third alternative was to support creation of a separate urban transit trust fund or a single fund from which both highway and mass transit programs could be financed at local discretion. A final option was to minimize the interaction between highway and transit programming by increasing federal appropriations for urban transit while leaving the highway program untouched. The politics of the federal highway and urban transit programs during the recent past should be understood as competition among these options.

Williams' efforts to assist urban transit lost momentum during the second half of the 1960s. Transit forces were still unable to mount a broad-based and sustained lobbying effort. The victories of the early 1960s had been due in large part to the pressure exerted by a few eastern railroads, and the legislation was seen as benefiting a few large cities--Chicago, Boston, New York, and Philadelphia--whose commuter services were threatened with collapse. Urban transit assistance became part of the Great Society program during President Johnson's tenure and met the same resistance as other parts of that program from Republicans and conservative Democrats. The Housing and Home Finance Agency gave urban transit low priority and put up little resistance when the Urban Mass Transportation Administration was transferred from HUD to the Department of Transportation.

But new support from President Nixon and his Secretary of Transportation, John Volpe, made urban mass transportation problems a priority item for the new administration. With seeming support from the administration and at the urging of transit supports in DOT, Volpe began touting the idea of a separate mass transportation trust fund in 1969, and Senator Williams and House transit advocates introduced legislation to create such a fund, to be supported by an excise tax on new cars. But Nixon, whose budget office and economic advisors convinced him that trust funds hindered their fiscal flexibility, rejected the trust fund idea, and introduced a $10 billion, 12-year program of capital grants to mass transit.

At the same time, changing circumstances and renewed effort gave the transit forces greater clout. The failure of bus and rail transit systems in rapidly growing cities in the South and Southwest, and the desire of those cities to build transit systems to their suburbs brought Republicans and Southerners into what had traditionally been an urban,

Democratic coalition. With leadership from the National League of Cities-U.S. Conference of Mayors, other groups--labor unions, manufacturing interests, officials of small and medium-sized cities, and the transit trade associations--were brought together in a coherent, effective lobbying effort.

The transit coalition bargained with highway advocates, trading pledges of neutrality. Highway interests agreed not to oppose new UMTA authorizations in exchange for a pledge that transit advocates would not oppose extension of the Highway Trust Fund.

In 1970, the transit advocates were able to use their new-found influence to pass legislation authorizing DOT to distribute capital grants totaling $3.1 billion. Cities planning capital projects had complained that the uncertainty created by annual grants was hindering efforts to get local and state matching money. The new legislation authorized long-term contracts between grant recipients and UMTA, providing greater certainty that federal funding would continue for the duration of transit development projects.

During 1970, highway interests succeeded in extending the Trust Fund through 1977, but were forced by pressure from the White House and urban antihighway groups to make funds available for highway safety.

Thus, events in 1970 established the tactical pattern for advocates of balanced federal transportation expenditure: half-hearted efforts at Trust Fund diversion and extended pressure to increase appropriations for UMTA capital grants.

Support for diversion came from the Nixon administration, which had repeatedly urged that the urban portion of the federal highway program and the urban transit program be merged in a unified fund. The second major source of support for diversion was the array of urban and environmentalist groups--joined in the Highway Action Coalition--whose main concern was with the adverse impacts urban highways on neighborhoods and air quality.

While the transit lobby was split on the issue of diversion, at least some elements of it--particularly bus transit interests--were cool to diverson and clearly preferred to avoid confrontation with highway supporters by increasing transit funding from the general fund. Bus companies contented that even if diversion from the Trust Fund were successful, there would not be enough money in the Fund to satisfy transit needs, but a successful diversion might weaken support for a further effort to increase direct aid to transit from the general fund. They have also feared that a unified Fund would spell the end of the Urban Mass Transit Administration, which administers direct aid to urban transit, allowing highwaymen to capture control of transit spending levels.

In its 1972 review of highway spending, the Senate Public Works Committee--long a bastion of support for the Highway Trust Fund--responded to pressure for diversion by reporting out a bill that allowed diversion of Fund money for highway-related mass transit. In 1970, Congress had added the Urban System to the federal aid program establishing a category of urban highways separate from the urban segments of the Interstate System.

The 1972 bill made an eightfold increase in the money available for the Urban System from the Fund--to $800 million--and allowed $300 million of that to be spent for highway-related bus transit. An effort in committee to allow diversion for rail mass transit failed narrowly. Similar efforts on the Senate floor and in the House failed. The conference version of the bill did not reach the floor at the end of the 1972 session, leaving the states strapped for funds and the stage set for a renewed diversion fight in 1973.

Returning to the legislation in 1973, the Senate Public Works Committee again rejected amendments to a new highway bill that would have allowed diversion of urban highway funds for rail mass transit. When the bill reached the floor, Senator Williams, who had developed a new transit bill designed to provide increased capital grant money and operating subsidies for existing systems, succeeded in getting the transit provisions attached to the highway bill by a vote of 59 to 36. The measure provided $3 billion in new capital grant authority through 1977 and $400 million per year in operating subsidies. The measure, which authorized appropriations from the general fund only, was endorsed by Senator Jennings Randolph, Chairman of the Public Works Committee and a key protector of the Highway Trust Fund. Some objection to operating subsidies was voiced, but debate on the measure was limited.

An amendment offered by diversion forces allowing cities to decide whether to use up to $2.3 billion in urban highway funds for mass transit failed, 70 to 23. But a less drastic diversion amendment, allowing cities to use the $850 million per year devoted to the Urban System for mass transit purposes, passed, 49 to 44. Debate on these diversion measures reflected strong opposition from supporters of the Highway Trust Fund and fear on the part of Senators from rural states that diversion would sap funding for rural road-building. Diversion supporters met these arguments with assurances that Trust money for the Interstate and other rural highway programs would not be touched. Some diversion from the Interstate was in fact allowed in the Senate bill--where an urban portion of the System was stalled by community opposition and found unnecessary to the network--but that provision does not seem to have influenced the debate on the bill.

The House was less sympathetic to diversion. An amendment in the Public Works Committee to allow diversion similar to that in the Senate bill failed, 29 to 8. The committee version of the bill did not allow operating subsidies, but did provide $1 billion per year for capital grants from the general fund. And, in an effort to contain the argument

of diversion supporters that cities should have the choice whether to spend federal money on highways or transit, the committee bill allowed cities to return Trust Fund money to the Fund and apply for similar amounts for transit from the general fund. On the floor, another attempt to permit diversion of Trust Fund money for transit purposes failed, 215 to 190.

Debate in the House focused on the diversion issue. Supporters of diversion recited the transportation troubles of the cities and argued that the current energy shortage and new federal air pollution requirements were imperative for cities to reduce automotive traffic and develop mass transit. Opponents of diversion argued for direct aid to urban transit from the general fund, saying that diversion of Trust Fund money would be inadequate to meet transit needs while damaging the highway program. Rural representatives feared loss of money for nonurban road programs and claimed that the Trust Fund was not large enough to even meet highway needs in the future. They also objected to use of taxes paid by highway users to finance urban transit. Diversion advocates emphasized that the Interstate and other rural road programs would not suffer and that urban representatives had frequently supported subsidies to rural interests in the past. Opponents also argued repeatedly that diversion would "breach faith" and violate a commitment to highway users made when the Trust Fund was formed.

Behind the diversion forces in Congress lay an increasingly active lobbying effort by the Highway Action Coalition, an alliance of antihighway environmental and community groups. The transit lobby supported efforts in both houses to increase direct aid to transit from the general fund, but remained split on the diversion issue and did not actively support the attempts at diversion made during consideration of the 1973 highway bill.

At the same time, state governors began pressing more actively for greater flexibility in spending federal money for urban areas. As diversion neared feasibility, a conflict developed between big city mayors and governors over the degree of control states would exercise over expenditure of federal money on urban areas. Both the Senate and House versions of the 1973 highway legislation allowed specific percentages of a state's federal money to go straight to large urban areas, a major departure from existing law. Governors resisted this encroachment on their control over highway funds and, for the same reasons, tended to support new transit funding in the form of diversion of Trust Fund money, which would still come through state government, rather than direct aid to the cities from the general fund.

In conference, the central issue was again diversion. An attempt to add an operating subsidies provision to the House measure had failed on the floor, and the operating subsidies provided for in the Senate version of the legislation were dropped. The Nixon Administration vigorously opposed subsidies and threatened a veto. The conferees agreed to provide $3 billion of new capital grant money from the general fund for the

transit aid program, and to allow transfers of money from cancelled Interstate segments to mass transit projects, but a deadlock developed over diversion. Senate conferees insisted on their position, and a compromise finally emerged that allowed a phased transition to diversion. At first, Trust Fund money rejected by cities would have to be replaced by general fund money for transit. Then Fund money would become available for bus transit, and finally urban highway system money from the Fund could be used directly for rail transit.

Frustrated in his attempt to add operating subsidies to the 1973 highway legislation, Senator Williams, along with Democratic Representative Joseph Minish of New Jersey, moved a two-year $800 million subsidy bill through the Banking and Currency Committees and got floor approval for two somewhat different versions in 1974.

At the same time, the Nixon Administration reversed its opposition to operating subsidies, partly in response to the new energy crisis induced by the Arab oil embargo following the October War in 1973.

Within the Administration, Transportation Secretary John Volpe seems to have been the most influential advocate of transit operating subsidies. The *National Journal* described his conversion to an advocate of transit operating subsidies:

> ""In November [1971], Volpe's department circulated a draft of a report to Congress on the feasibility of operating subsidies. The verdict was a brusque 'no'."
>
> The attitude of the department has turned around since then.
>
> "Ronan [William J. Ronan, Chairman of the New York Metropolitan Transit Authority] went right to work on Volpe while that report was in draft state." Transit Lobbyist Fred Burke said, "and by the time the final report was submitted Ronan had gotten all the teeth pulled.
>
> "Ronan got Volpe to order a review of it, by using the political argument that he represented the loyal Republican Governor from the second biggest state, that he had a serious problem, and that he was being forced to work with a Democratic Senator because he couldn't get a sympathetic hearing from his own Administration."
>
> In January, Ronan persuaded Volpe to meet with subsidy lobbyists. Ronan, Pritchard [of the Conference of Mayors], and Gunther [of the National League of Cities] won him over.
>
> As Burke relates the story: "First, Pritchard hit him hard with the argument that a subsidy based on

ridership would reward the productive and penalize the inefficient.

"Then Ronan hit him hard with the argument about how severe the need was at the local level, and then Gunther warned him that the case was so desperate that the locals--mayors and transit officials--were working the Hill so hard for relief that the issue was probably out of political control already."

From that point on, Volpe became a reluctant champion of operating subsidies and ordered a high-level task force within the department to come up with various formulas for administering a subsidy program.

Thus the Administration opposition was scattered. Even though the Office of Management and Budget remained hostile, the solid front was broken and the transit coalition had won over an influential, if reluctant, champion.""

In search of a strong domestic policy to offset the Watergate scandal, the Nixon Administration proposed a Unified Transportation Assistance Program (UTAP), a six-year, $16 billion revenue-sharing measure that would have combined federal spending for urban highways and mass transit under a single fund in 1977. By including highway provisions in the proposal but not altering the use of the Highway Trust Fund for rural or Interstate construction, the Administration insured that the proposal would be referred to the Public Works Committees instead of the urban-dominated and transit-oriented Banking and Currency Committees. The Administration saw the chance to seize the transit issue for its own. It wanted to avoid any reshaping of its proposals into big city subsidy measures in the Banking Committees--even if that meant submitting its diversion proposals to the ministrations of the Public Works Committees. The Administration got promises to speed the measure through, and it was introduced with the support of key highway supporters from both Public Works Committees. At the same time, a rules technicality was used to bottle up the Williams-Minish subsidy bill in conference.

These machinations precipitated a major jurisdictional dispute between the Public Works Committees. For the second year, transportation legislation contained major elements dealing with both highway and non-highway urban transit, and neither set of committees had clear jurisdiction. Which committees prevailed made an important difference. The Senate committees differed sharply on diversion--Banking and Currency voted 12 to 3 in favor, and Public Works had voted 6 to 8 against it in the 1973 highway legislation. A similar difference in diversion had divided the House Committees: 27 to 10 in favor on Banking and Currency and 27 to 7 against on Public Works in 1973. Within the House Public Works Committee, there was a split among Democrats between urban representatives who support diversion and direct transit aid. Rural members

opposed diversion and remained committed to highway-only programming. Republican members opposed diversion almost unanimously. Neither Public Works Committee opposed direct aid to transit, so long as it did not go to a small number of the largest cities.

Consistent with these inclinations, the House Public Works Committee reworked the Administration's UTAP proposal considerably, omitting any provision for the highway program (and thereby the ostensible ground of the committee's jurisdiction) and increasing general fund grants for transit from $9.5 billion to $20 billion. As this proposal was readied, the Williams-Minish bill finally emerged from conference, but was promptly recommitted by the House, which was preparing to review the Public Works program.

Both the Williams-Minish and the House Public Works bill encountered strong opposition from rural and some smaller urban legislators on the ground that allocation formulas in the measures were designed primarily to aid a few big cities, particularly New York. These opponents, along with conservatives, wondered whether the cities had made sufficient effort to help themselves through local taxes, bonding schemes, and efficient transit management. Operating subsidies, they argued, would promote ineffective management and create an open-ended federal commitment to prop up failing systems. They also argued that transit operating unions would capture the subsidies in wage increases. The level of spending in the Public Works legislation was also attacked as inflationary and certain to bring a presidential veto.

Supporters of the transit measures argued elaborately that the cities were bearing their share, that cities other than the few largest ones would benefit from the bills, and that the Public Works legislation provided extensive benefits to rural areas as well. A concerted effort was made to present the transit problem as a national concern, and the House bill renamed the Urban Mass Transportation Administration, the Federal Mass Transportation Administration.

The House measure passed, 324 to 92, but only after amendments were added decreasing the amount of federal operating subsidy provided, spreading coverage of the bill to more and smaller cities and cutting the spending level from $20 billion to $11 billion.

Senator Williams, however, promptly stopped the House bill in the Senate Banking and Currency Committee. As the ensuing deadlock continued, pressure from big city mayors built up on Congress and the Administration. In this urgent atmosphere, Williams negotiated with the Ford Administration, newly won over to support of operating subsidies. Ford's change of mind reflected increasing DOT concern that cities eager for federal *capital* grants were over-investing in new, capital-intensive projects instead of trying to run existing systems more efficiently. Operating subsidies would restore balance.

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The measure that emerged from the negotiations provided $7.8 billion for capital grants and $3.6 billion for either capital grants or operating subsidies for a six-year period. No new provision was included for the highway program. Williams had the conference approve the measure under the same number as his two-year operating subsidy bill had borne, and got Senate approval first, an unusual move designed to pressure the House to pass the bill. Amid complaints from the House Public Works Committee, the House approved the legislation.

The Future of the Transit and Highway Programs

New consideration of the Highway Trust Fund is due this year, and transit forces have made it clear that the compromise transit measure passed last year contains too little coherent federal transit policy and too little funding to satisfy them. President Ford early this year proposed a plan to divert half of the gas tax revenues to the general fund with permission for the states to similarly divert state revenues, and to limit spending from the Trust Fund to the Interstate System alone after 1977. Funds impounded from the Trust Fund in order to fight inflation over the past several years would also be released into the general fund.

The recent battles over federal transit money indicate that, while the cause of urban mass transit has gained significant ground and highway supporters in Congress have had to retreat slightly on the diversion issue, the highway advocates remain powerful in Congress. Though only a few cities have made use of the diversion provisions of the 1972 highway legislation, it seems likely that efforts to make major diversions from the Trust Fund will continue. The feasibility of abolishing the Fund altogether has also increased somewhat, and Senators Edward Kennedy and Lowell Weicker have introduced a bill to do away with the Fund in September 1976. It seems more likely that Trust Fund supporters will be able to divide the transit faction by supporting direct aid from the general fund and to play on rural fear of losing rural highway money. This seems likely to maintain at least the Interstate and probably the entire nonurban elements of the Fund intact, at least until the Interstate is "completed" sometime after 1980. Direct aid to urban transit, in the form of capital grants and operating subsidies, will almost certainly increase. Ultimately, it seems likely that the levels of funding for highways and urban transit will be brought into more approximate balance, and that the funding mechanisms used for the programs will be gradually combined or at least made more nearly similar. Whether this will mean a unified trust fund remains difficult to predict: the trust fund mechanism retains great appeal for legislative branch but is opposed by executive branch budgeters as too inflexible.

Though this general result seems to follow from the trends shown by recent events, these trends could be slowed or bent by jurisdictional developments in Congress. In 1975, the House Public Works Committee assumed jurisdiction over highway and urban transit legislation. This seems likely to mean that continued direct aid to urban transit will

have to be purchased with moderation on the diversion issue, an approach that Senator Williams has used in the past. And this promises in turn that the Highway Trust Fund, slightly modified for urban programs, will remain reasonably intact for some time to come.

Appendix B

CASE HISTORY NO. 2: THE FORMATION OF AMTRAK

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The Decline of Rail Passenger Service

Rail passenger travel in the United States peaked in years following World War II and then declined drastically. Travel by motor vehicle and airplane increased dramatically during the same period. The rail share of paid intercity passenger traffic declined from 72.9% in 1946 to 15% in 1970, and only 1.5% of all intercity travelers used rail in 1970. Railroad management has attributed the decline to federal highway funding, outdated union work rules, and federal regulatory practices. As patronage declined and operating losses increased, railroads lost interest in passenger service and pressed for abandonments. Industry critics charge that railroads let service deteriorate and actively discouraged passengers to bolster their case for abandonment.

In 1958, Congress amended the Interstate Commerce Act to give the Interstate Commerce Commission (ICC) the power to allow discontinuance of unprofitable passenger runs. In the decade following that amendment, the ICC proved amenable to discontinuance, allowing 416 of the 1,448 intercity runs existing in 1958 to cease. State agencies let a slightly larger number of intrastate trains stop running, leaving 576 trains in operation in late 1968. Of those, few were profitable. On most, ridership and revenues continued to drop and service to deteriorate.

Early Federal Activity

Northeast Corridor Transportation Project. The decline of rail passenger service was felt acutely in the densely populated "northeast corridor" between Boston and Washington, D.C. In 1962, Senator Claiborne Pell (Democrat--Rhode Island) introduced legislation to create an eight-state regional transportation authority to help upgrade rail service for the area and pressed President Kennedy for support. The legislation failed in 1962 and in subsequent sessions, but a task force appointed by Kennedy recommended a study of the corridor's transportation needs. In 1963, Congress appropriated funds for the study, and the following year the program became the Northeast Corridor Transportation Project (NECTP) and was lodged in the Department of Commerce.

The Office of High-Speed Ground Transportation. In his 1965 State of the Union Message, President Johnson asked for $20 million to study high-speed transportation between Boston and Washington, D.C. This expanded into a proposal for $90 million to be spent over three years to:

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- Research new modes of high-speed ground transportation.
- Demonstrate projects designed to test the attractiveness of improved, high-speed conventional rail travel between Boston, New York City, and Washington.
- Accumulate transportation statistics.

About one-third of the funds were to be spent on the cooperative demonstration projects in which private railroads would test new rolling stock on improved roadbeds. The rest of the money was earmarked for research on more exotic modes. The NECTP indicated that approval of the New York City-to-Washington demonstration project was contingent on the willingness of the Pennsylvania Railroad to spend at least as much as the government on new equipment, an assurance the railroad soon gave.

The measure, linked to President Johnson's Great Society program, was adopted by Congress late in 1965 with no significant opposition. The bill's congressional supporters cited the need to bring federal research and development spending for rail transportation into balance with that for air, water, and highway modes and emphasized that the new project was not intended to commit the government to subsidizing rail travel. The stated purpose was to measure the ability of improved conventional rail systems to lure passengers away from increasingly congested airlines and highways, not a test of potential profitability.

The Office of High-Speed Ground Transportation was formed in the Commerce Department to conduct the research and demonstration programs and to continue the NECTP. The Pennsylvania Railroad began roadbed improvement and procurement of new equipment in preparation for the federal demonstration grant, and United Aircraft Corporation was awarded a contract for new turbine-powered equipment to be operated between Boston and New York City on the New York, New Haven & Hartford tracks. In 1967, the Office of High-Speed Ground Transportation was moved to the new Department of Transportation (DOT).

In 1968, despite delays in starting the New York-to-Washington service because of late deliveries and technical problems, a two-year $37.4 million extension of the 1965 legislation passed without opposition. In an economy move, the House Appropriations Committee had allowed only $52 million of the $90 million authorized for the program to be spent. The impounded funds were those for new ground-transit modes; the Boston-to-Washington demonstration projects continued untouched. The new authorization in 1968 was designed to allow spending up to the $90 million level and completion of both the original research and demonstration projects.

In January of 1969, the newly consolidated Penn Central Railroad began operating the New York-to-Washington Metroliner after spending over $30 million on track improvements and new equipment. The company expected to spend $20 million more before qualifying for a $12 million federal grant covering a two-year demonstration period. Despite minor

problems, the new service began to attract new passengers to the run, and new trains were steadily added to the run.

In April, the Penn Central began operating a Turbotrain between Boston and New York, using equipment leased by the Department of Transportation from United Aircraft. The new train cut 35 minutes from a run that took conventional trains more than four hours.

Prelude to AMTRAK. During 1968, applications to the ICC for discontinuance of passenger trains rose sharply. The ICC came under increasing pressure from railroads that wanted to discontinue passenger service--and from Congress and advocates of improved passenger service, who wanted the Commission to stiffen its stand on discontinuances and force railroads to improve the quality of their service. The ICC had maintained consistently that it would need new legislation to police the quality of passenger service, but the issue was forced in early 1968 when an ICC hearing examiner ruled that the Commission already had the power it needed to enforce quality standards. In June of 1968, the Commission asked for a Department of Transportation study of the rail passenger problem and for emergency legislation stiffening the ICC's ability to halt the deterioration in service. The ICC attacked railroad accounting procedures that, it claimed, allowed the roads to overstate their losses from passenger operations.

Senate and House committees held hearings on a bill authorizing a DOT study and imposing a moratorium on discontinuances until new rail passenger policy was set, but no floor action was taken on the legislation. Senator Warren Magnuson, Democrat of Washington and head of the Senate Commerce Committee, asked the ICC to make a new study of rail passenger losses, and the Commission agreed.

The study, released in July of 1969, concluded that eight railroads carrying 40% of the nation's noncommuter passengers during 1968 lost $118 million in the operation of passenger services. The loss figure for all railroads carrying passengers approximated $170 million. The study claimed that the rail passenger system was in danger of collapsing without federal action. The ICC renewed its request for a major DOT study of the rail passenger problem and for interim authority to halt the deterioration of service. Pressure to do something about the problem increased in Congress, and Senator Vance Hartke (Democrat--Indiana), Chairman of the Senate Commerce Committee's Subcommittee on Surface Transportation, promised hearings to consider the ICC request and legislation designed to rescue passenger service.

Before hearings could be held, the ICC overruled its hearing examiner's finding, and stated that the Commission lacked the authority to enforce quality standards on rail passenger service.

The 1969 Senate hearings, and later ones in the House, were held in an atmosphere of renewed urgency. The ICC once again pressed for a study

and a moratorium on discontinuances, saying it was premature to take any action beyond that. Many individual railroads--particularly Western railroads with very long-haul runs--still wanted to drop their passenger service entirely. But others--like the Penn Central with shorter runs in more densely populated corridors--did not. The industry trade association, the Association of American Railroads (AAR), switched its pro-discontinuance stand early in 1969 to favor federal subsidies to make up the operating losses suffered under ICC continuance orders, and it pressed this position at the House and Senate hearings. Passenger bus interests attacked subsidy proposals, claiming they would discriminate unfairly in favor of the less efficient railroads. The National Association of Railroad Passengers (NARP), a small but vigorous passenger lobbying group assembled by a Chicago attorney, urged subsidies of $200 million per year for four years. The Federal Railroad Administration, speaking for DOT, claimed that only short-haul service in highly populated areas was salvageable, and urged Congress to wait for the administration to develop a plan for selective abandonment and assistance.

As the year closed, DOT had yet to make its proposal, but it was said to be leaning toward allowing a semipublic corporation to run rail passenger service instead of outright subsidies or matching grants from a trust fund in the manner of the federal highway and airport programs. The Senate subcommittee had developed a subsidy approach, but held off in anticipation of an administration proposal promised by the new year.

Formation of AMTRAK--1970 to 1971. Early in 1970, Transportation Secretary John Volpe proposed a plan for a semipublic corporation--to be known as Railpax--that would contract with railroads for passenger service on a national network of routes chosen by DOT. Federal assistance--loan guarantees and direct grants--would be given to the corporation to finance the contracts. High White House officials and the Bureau of the Budget vetoed the plan, however, to Volpe's surprise. The ICC also objected to the plan, and a general administration reluctance to rescue passenger service was reported. DOT officials asked for more time from the Senate Commerce Committee and continued to voice administration objections to outright subsidies. Subsidies, it was contended, would involve the federal government too deeply in rail operations without getting the railroads' passenger operations back "on their own feet."

After repeated administration delays and renewed petitions to discontinue passenger trains, the Senate Commerce Committee acted unilaterally. The Committee had worked up its own version of the semipublic corporation plan and was reported to favor it over direct subsidies. Instead the Committee approved legislation calling for $435 million in direct federal aid over four years. The measure authorized DOT to designate a national rail passenger network and pay up to 80% of the losses of railroads operating trains in the network. The bill also created a $195 million fund for government purchase and rehabilitation of equipment, the purchased equipment to be leased to railroads on the system.

Discontinuance procedures would be eased for lines outside the system and stiffened for those within. DOT was also given authority to enforce quality standards for lines in the new network.

The Committee's move brought quick action from the Nixon Administration. Administration representatives, key Senate Republicans (some opposed to subsidies), and Commerce Committee members arranged to substitute a semi-public corporation plan for the Committee's subsidy bill on the Senate floor. The new plan allowed railroads to free themselves of their passenger operations by paying the new corporation to take over the services. Railroads that did not join the new plan could not discontinue service until 1975. The corporation would contract with roads that joined to provide passenger service along a designated national network. The measure authorized $40 million of direct aid to the corporation, $60 million in loan guarantees for equipment purchase and track repair, and $75 million in loan guarantees to back borrowing by railroads to buy into the corporation. The measure also required the corporation to add routes requested by state or local authorities if they were willing to share the operating losses of the run on a 50-50 basis with the corporation.

The measure had near unanimous support in the Senate. Labor groups, AAR, NARP, the ICC, and DOT all favored the measure. Though the new plan favored short-haul runs somewhat more than the original DOT proposal, there was some concern that profitable short-haul runs--such as the Metroliner was proving to be--would end up subsidizing unprofitable long-haul runs. But a measure introduced by Senator Pell designed to separate operation of long- and short-haul runs found little support and was withdrawn. The corporation plan was presented as a means of getting rail passenger service back on its feet, and DOT predicted the corporation would show a modest profit within five years. With little debate and some relief at not having to authorize large direct subsidies, the measure was passed, 78 to 3.

The House acted to increase authorizations to $100 million for loan guarantees for operations and $200 million for loan guarantees to back borrowing to buy into the system. The House version would allow the corporation to discontinue unprofitable trains in the network in 1973--two years earlier than the Senate bill. The House increased the share of operating losses state or local bodies would have to match from one-half to two-thirds. The measure passed the House with little debate and was approved by the Senate. Transportation Secretary Volpe had to muster a last minute show of force when the Council of Economic Advisers, the Budget Bureau, and White House staffers again balked at the plan, but President Nixon signed the law late in 1970.

In November of 1970, Volpe announced preliminary plans for the national rail network that would be operated by the new corporation. By then only 366 passenger trains were still operating, and the plan called for trimming that to 150. Volpe was constrained by the relatively limited original funding of the program, the profitability criterion, and the

intervention of the Budget office. He claimed that the network would still provide 90% of the 122 million people in cities of 50,000 or more with train service, but entire areas and some large cities were left unserved by the plan, and several major long-haul routes were omitted.

There was immediate criticism of the network proposal from many of the corporation's original supporters. The ICC and NARP both attacked the plan as inadequate and proposed extensive revisions. Congressmen and Senators from areas omitted from the plan, including Senator Magnuson, pressed for inclusion of service in their areas. The role of the Office of Management and Budget (OMB) and some railroads interested in keeping their runs out of the system were attacked. Unions, despite labor protective clauses in the original legislation, expressed fear that the drastic cuts in service would threaten thousands of jobs.

In March of 1971, DOT revised their plan to add New Orleans-Los Angeles and Seattle-San Diego routes to the original system and increase the number of trains to 184 daily. The plan left six states unserved and provided no service to Cleveland, once a major rail center. Despite industry concerns that the venture was underfunded, Volpe predicted that it would be profitable within three years and could then expand to meet demand for more passenger service.

Rather than mollifying critics, the revised plan created new resistance. Both union groups and NARP filed federal court actions to prevent startup of the corporation, now called AMTRAK, in May of 1971. Key congressional supporters of the original legislation, led by Senator Mike Mansfield and Chairman Harley Staggers of the House Interstate and Foreign Commerce Committee, mounted an effort to delay the program until it could be expanded. Hearings were held in both Houses, and Mansfield, with support from Chairman Magnuson, sought approval in the Senate Commerce Committee of legislation to delay start-up. The committee rejected the move, however, and a unanimous consent request to get the measure to the Senate floor failed. At the same time, both the union and passenger group suits were rejected in federal court, and AMTRAK began operations on schedule.

High-Speed Ground Transportation--1970 to the Present. After their first year in operation, both the Boston-to-New York and New York-to-Washington demonstration trains were viewed as successful. The Metroliner had carried more than a million passengers by March of 1970 and had reversed the decline in passenger traffic between New York and Washington, D.C. After more delay due to technical difficulties, the Penn Central began receiving $12.9 million from the government under a two-year demonstration program intended to test the market performance of the Metroliner. And early in 1971, DOT signed a $3.8 million contract with United Aircraft to continue Penn Central's Turbotrain for two more years, fulfilling a campaign promise President Nixon had made to Connecticut voters in 1970.

During 1970, Congress considered a request for $21.7 million to continue the work of the Office of High-Speed Ground Transportation for another year. In addition to work on the demonstration projects, the agency had conducted research on new technology--linear induction motors, tracked air cushion vehicles, tube vehicles, and STOL and VTOL--which it wanted to continue, and had completed the Northeast Corridor study in draft version that it wanted to refine. The measure went through Congress easily. Mention was made in floor statements of the visible success of the program and its relatively small cost (about $78 million so far). Bus, road building, and air transport groups, surveyed at the time, felt no threat from the program, although coastal airlines had begun to feel the impact of the Metroliner and were objecting independently to further support for the project.

Late in 1971, DOT released the final report on Northeast Corridor transportation. In what was regarded as a major shift of governmental priorities, the study claimed that improved conventional rail systems offered the only hope of meeting the area's intercity transportation problems in the coming decade. Transportation Secretary Volpe emphasized that the plan would not cause much disruption since it would only improve existing facilities, but warned the use of new modes in the future might have considerable environmental impact.

At the same time, renewal of the federal high-speed ground transportation program was again before Congress. Backers of the program, concerned that it had to return to Congress every year or two for deferral of its termination date and an increase in authorizations, sought to make the project continuous by removing the termination date and lifting the limitation on appropriations. The measure passed the Senate with no opposition late in the year. Early in 1972, the House passed a bill that removed the termination date of the project, but specifically authorized $315.2 million for the following three years. The House measure also authorized new research into door-to-door transportation services and extended the repayment period of loans owed by the project. A conference adopted the House measure with few changes.

Late in 1972, DOT announced that it would urge Congress to spend $700 million to implement the recommendations of the Northeast Corridor report. At the same time, Senator Hartke and Senator Lowell Weicker, a Connecticut Republican, announced that they would introduce $5.5 billion legislation the following year to improve conventional rail travel in the Corridor by 1976 and then construct a new 400-mile-per-hour system during the following decade.

Hartke and Weicker eventually introduced only the first half of their plan, and the concept behind both that plan and the DOT proposal ultimately emerged as part of the 1973 Regional Rail Reorganization Act. The accelerating failure of passenger lines in the late 1960s foreshadowed a more serious problem with the nation's rail freight system. In 1970, after attempts to get emergency federal aid failed, the Penn Central filed for bankruptcy and was followed in the next few years by

other major railroads in the Northeast and Midwest. After extensive controversy, Congress created the U.S. Railway Association, charging it to draft a plan for operating bankrupt railroads under a new, semipublic, for-profit corporation, to be called ConRail. One goal of the reorganization, according to the Act, was to be the improvement of passenger service in the Northeast Corridor. The Act orders a study of the equipment and property AMTRAK would have to purchase or lease from ConRail to improve service in the corridor. AMTRAK is required to carry out this plan and may borrow from ConRail, with a federal repayment guarantee, to do it. The legislation contemplates that the program will become profitable. (Expenditure of $700 million over five years will be needed to carry out the improvements.)

AMTRAK--1971 to the Present. By late 1971, less than six months after its formation, AMTRAK had exhausted its original $40 million grant and was projecting a fiscal 1972 loss of $150 million--$50 million greater than predicted. Secretary Volpe asked Congress for $170 million to cover the period until June 1973, when AMTRAK could begin cutting unprofitable routes from its network.

Congressional reaction to the request and to AMTRAK's first six months of performance was vehement. The congressional Commerce Committees that had supported the AMTRAK plan were disappointed with the corporation's performance but reluctantly supported Volpe's request. Routes had been added to the rail network to satisfy key congressmen--including Mansfield, Staggers, and Magnuson--but complaints of incomplete service persisted. The Senate Commerce Committee, and Senator Hartke in particular, were angered by the performance of AMTRAK's management, claiming that it was under-aggressive and over-salaried. Critics also said the corporation had been too passive in its negotiations with the railroads. AMTRAK contracts with the railroads for provision of passenger service required automatic payment, leaving AMTRAK without leverage to force the roads to improve the quality of service or the reliability of schedules.

This criticism was echoed by the National Association of Railroad Passengers, which charged that the railroads were intent on sabotaging the new corporation in order to be free of passenger operations for good. The railroads, it was said, were overstating losses, giving bad service, and purposely delaying passenger, in favor of freight, trains.

Administration critics leaked rumors that the Nixon Administration, which had never strongly favored federal support for rail passenger service, intended to give the corporation minimal funding through the 1972 election, then let it die. Both AMTRAK and DOT officials, it was charged, were being prevented from requesting more than $170 million by the White House.

The ICC agreed with the corporation's supporters who claimed it needed, if anything, more money. Bus transport spokesmen opposed any new funding for the project, contending the government was committing

itself to a billion dollar subsidy program in the future. Labor groups resisted congressional suggestions that AMTRAK take over actual operation of the trains, claiming that would destroy seniority rights of trainmen who lose passenger jobs and want to be placed in freight jobs.

In March of 1972, the House passed 312 to 63, a bill giving AMTRAK the requested $170 million, and requiring it to give annual performance reports to Congress.

Senator Weicker successfully pressed the Senate Commerce Committee to add $250 million to the $170 million request, and Senator Pell won amendment on the Senate floor, adding $150 million worth of loans and loan guarantees for roads in 15 designated urban corridors. The measure, totaling $570 million in all, passed 73 to 7.

A conference committee cut the Pell amendment from the bill entirely and reduced the general authorization for AMTRAK in the Senate bill from $420 million to $325 million--$225 million in direct grants and $100 million of loan guarantees.

Many of the same criticisms leveled against AMTRAK in 1972 were renewed in 1973. The corporation was still providing sometimes inadequate service over a skeletal network and still functioned largely as a conduit for federal funds to railroads that were reluctant participants in the scheme. The corporation amassed the feared $150 million deficit in Fiscal 1972.

Early in 1973, AMTRAK, under pressure from OMB and DOT, petitioned to discontinue 3 of its 21 passenger routes and asked less than $100 million from Congress for the coming fiscal year.

Support for AMTRAK--and ire at the interference of OMB--had grown in Congress, however, and pressure was exerted to force AMTRAK to withdraw its discontinuance petition. In June, the Senate passed, with no debate, an authorization of $185 million in grants and an increase of $250 million in loan guarantees. In September, the House passed a grant of $107.3 million and new loan guarantees of $50 million. The House measure also included a provision prohibiting AMTRAK from submitting budget requests to DOT and OMB before Congress. The bill also required consumer representation on the corporation's board, and gave AMTRAK more leverage over the quality of the service it purchased.

A conference committee came up with a compromise bill containing $154.3 million in grants and raising the loan guarantee level by $250 million. The grant figure represented the $107.3 million the House originally passed, plus $47 million of the previous year's grant authorization that had not been appropriated. The conference bill also moved the time when AMTRAK could discontinue parts of its service to mid-1974, eliminated OMB and DOT reviews from the AMTRAK budget process, ordered the corporation to begin adding experimental routes to its system, and gave the ICC power to review the quality of passenger service provided through

the corporation. The measure passed both Houses easily and President Nixon, feeling pressure from Watergate and the sharpening energy crisis, signed the bill in November of 1973.

Though AMTRAK's Fiscal 1973 deficit was again close to $150 million, the corporation could claim increased ridership and increased revenues, bolstered by gas shortages. The energy crisis was also reported to have changed the Administration's posture toward AMTRAK. It asked $140 million for Fiscal 1975 with no resistance from OMB. AMTRAK itself requested $200 million.

In July of 1974, the House passed 317 to 67, a measure to grant the corporation $200 million and increase its loan guarantee authorization by $400 million. There was still considerable concern in the House with extending the AMTRAK network and displeasure with the performance of the railroads under the plan, but there was increasing support for keeping AMTRAK in business and testimony arguing the legitimacy of continuing federal subsidy as a necessary national service. One month later, the Senate passed 75 to 31, a measure calling for the same money amounts. A conference committee reported a bill prohibiting discontinuances of any routes until mid-1975 and requiring addition of at least one experimental run per year. Priority was given to states not already served by the network. The Legislation also mandated AMTRAK to assume its own equipment maintenance and to provide service to any local or state body providing two-thirds of the requested line's losses. It also authorized a feasibility study of high-speed ground transportation on the West Coast. President Ford signed the bill in October of 1974.

Despite increases in ridership and passenger revenues, AMTRAK's Fiscal 1974 deficit approached $200 million, due to sharply rising costs. The Administration requested new funding for the corporation until 1977 in the form of direct grants only, an implicit acknowledgment of AMTRAK's inability to turn a profit in the foreseeable future. The corporation had already run up a federally guaranteed debt of $860 million, and there is little prospect of its being repaid. Thus, the federal guarantee is little more than a deferred subsidy. Debate on the measure in the House showed that there was still dissatisfaction among congressmen who were being asked to approve substantial and rising federal expenditures for a rail network that did not serve their districts. At the same time, floor statements revealed sentiment for removing the influence of congressional politics from the route selection process and letting AMTRAK concentrate on the more efficient runs in its network, a move that would reduce the corporation's operating losses. In April, the House passed 280 to 63, a $1.12 billion authorization for direct grants to AMTRAK through October of 1977 and a prohibition of discontinuances through March of that year.

Thus debate over AMTRAK since its inception has centered on a tension between the insistence that it eventually operate independent of federal support, and the idea that national rail passenger transportation is a merit good government owes to the public. There has been a steady trend

in the public discussion of the program away from the former idea and toward the latter, but Congress has yet to explicitly decide the issue. AMTRAK's estimated deficits for Fiscal 1975 through 1977 are estimated at over $300 million each year, so it seems likely that the decision whether to subsidize passenger service indefinitely could be made by default--the unfortunate but inevitable consequence of preventing the service from complete collapse. But a criterion of profitability dies hard. It underlies the congressional plan to reorganize the rail freight system, it still appears in debate over the passenger system, and it is still part of the system's basic legislation.

As the feasibility of the profit goal declines and congressional insistance on new service grows, it seems likely that appropriations will continue and mount without explicit acknowledgment that AMTRAK--or its successors--will require permanent operating assistance.

V. MACROECONOMIC ISSUES THROUGH THE YEAR 2000

by

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ABSTRACT

Key parameters that will affect the state of the U.S. economy through the year 2000 are described.

There has been a capital shortfall and U.S. underinvestment in new plant and equipment during the past decade spawned by the increasing needs of capital intensive industries (especially energy conversion) and declining corporate earnings (a prime source of investment capital). Ameliorating this problem is a possible reduction of capital needs in other capital-consuming areas (e.g., schools); also, anticipated future demand for electric power is probably overstated. Remedies for the capital shortage include tax reforms (e.g., affecting corporate incomes) and government direct investment. Public hostility to business makes the latter option more likely.

The decline of the "work ethic" and increased interest in "quality of life" at the expense of economic reward have contributed to the current economic slowdown. The principal constraint on growth over the next decades is, however, likely to be economic policy and not--as in the past--the ability and willingness of workers to accept and assimilate new production methods. The technological base for a rapid acceleration of productivity is available in the immediate future; for example, the application of computers to automation of physical production processes is still in its infancy.

The inverse interrelationship of inflation and unemployment is a consequence of the capacity limitations of both industry and labor. At a certain level of demand, unused capacity is exhausted in certain "bottleneck" sectors which are often artificially constrained by industry or (usually) union monopoly power. Organized labor has reaped virtually all the benefits of rising productivity, and labor costs have outpaced productivity in some sectors. Rampant inflation affects disorganized consumers (e.g., the poor and elderly), and capital, which is eroded because of accelerated depreciation due to rising replacement costs. Control of inflation depends on future cooperation of labor unions.

Institutional rigidities distort the free market mechanism for resource allocation. Labor union monopoly power often prevents technological progress in the short-term interest of union members. Intervention of the courts into substantive policy-making areas tends to decrease the flexibility of the social system as a whole. Another rigidity factor is the growth and proliferation of independent regulatory agencies.

The main impact of regulation on intercity transportation (ICT) is to ensure the delivery of services to localities where demand would not otherwise justify such services, with increased costs to all users, particularly larger cities. If regulation in the interests of small cities and rural areas were ended, their economic advantages vis-a-vis larger cities would disappear.

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The ongoing shift from extraction and manufacturing to the service sectors is most clearly seen in the declining relative importance of farming and "blue collar" jobs. An important subsidiary trend is the shift from certain services purchased directly from central suppliers toward services provided by privately owned equipment (e.g., the shifts from rental housing to private housing, from public transport to private cars, from commercial laundries to home washing machines), resulting in part from tax advantages (e.g., interest deductions and depreciation) accruing to "owners" of equipment providing a service, but not to renters of equipment or purchasers of the service itself. Tax law changes could affect the trend. A key related trend has been the rapid expansion over the past 30 years of industrial manufacturing of equipment that is substituting for formerly purchased services (i.e., single-family houses, cars, appliances); most of these markets are nearing saturation, except for communications and leisure/recreational markets, the latter continuing to increase as a factor in ICT demand.

Depletion of nonrenewable mineral resources can be alleviated by recycling, stockpiling, and substitution. The U.S. will, of course, be heavily dependent on foreign sources of fossil hydrocarbons for at least 10 to 15 years, despite accelerated exploration for, and use of, coal. The era of "cheap" energy is over, and future declines in energy prices (e.g., due to OPEC's collapse) will be temporary.

The impact of permanently higher intercity transportation energy costs is clear. "Energy intensive" modes (aviation and private autos) will suffer increased costs vis-a-vis their competitors (rail and bus). Increased costs, of course, affect profits, prices, and levels of service and demand.

V. MACROECONOMIC ISSUES THROUGH THE YEAR 2000

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V. MACROECONOMIC ISSUES THROUGH THE YEAR 2000

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Summary

In this paper, an attempt is made to establish the key parameters that will affect the state of the U.S. economy in the year 2000. A systematic review of the generally accepted "driving forces" of the economy is followed by a discussion of several important issues which have generated controversy in recent years. Each section concludes with a discussion of some of the implications for intercity transportation.

The first three sections are concerned with the general (cyclic) character of the economy and the factors affecting production and consumption, respectively. This general analysis is followed by discussions of six specific issues which arise in connection with any attempt to forecast the long-range future of the U.S. economy.

The first issue discussed in detail is that of capital requirements vis-a-vis availability. Arguments pro and con are presented. The shortage thesis is supported by evidence of significant underinvestment by the U.S. over the past decade or more, coupled with evidence of increasing needs from capital intensive industries (especially energy conversion) and declining corporate earnings--the ultimate source of most investment capital. Ameliorating the situation somewhat may be a reduction in anticipated capital requirements for some other capital-consuming areas such as schools. Also, anticipated future demand for electric power, for instance, has probably been overstated because it is extrapolated from an historical trend of declining real energy costs.

Future options for increasing capital availability include changing the tax laws, e.g., on corporate incomes, and direct investment by government. In view of the current public hostility toward business, the latter outcome seems more probable.

Productivity and technological change are discussed next. The issue here is whether U.S. productivity growth in "real" terms can continue at, or near, historical rates (2.1% per year per worker between 1950 and 1970) or whether a major shift is in the offing. A slowdown is rather widely expected, arising from a variety of sociological factors such as the declining "work ethic" and increased interest in "quality of life" at the expense of more conventional forms of economic reward. Evidence of changing social patterns is easily cited: rising crime statistics, drug abuse, the spread of the "counter-culture," absenteeism, wildcat strikes, etc. However, a deeper examination suggests that part of the social malaise that is widely cited as a precursor of the "end of growth" is probably symptomatic, instead, of a breakdown in the societal mechanisms of defense against change. The mechanisms which

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promote rapid social change--notably the electronic media--are of recent origin, and the application of electronic computers (for instance) to automation of physical production processes is still in its relative infancy. Thus, the technological basis of a rapid acceleration of productivity appears to be available now or in the immediate future. The principal constraint on growth for the next several decades is likely to be economic policy and not--as in the past--the ability and willingness of the labor force to accept and assimilate new methods of production.

The third issue discussed is inflation and unemployment. The immediate connection between the two phenomena arises because both industry and labor have capacity limitations. As demand rises beyond a certain point, unused capacity begins to be exhausted in certain "bottleneck" sectors--which are often artificially constrained by industry or (usually) union monopoly power. Indeed, organized labor has secured for labor--as opposed to consumers--virtually all the benefits of rising productivity. In fact, labor costs have recently risen faster than productivity in some sectors. The prospects for controlling this inflationary pressure depend on the future role of labor unions in the U.S. The adverse consequences of continuing inflation (should it be impossible to restrict or eliminate monopoly power) are felt by disorganized consumers--especially those who are not "producers," such as the poor and elderly--and by capital. The problem is that capital tends to be eroded by inflation because real depreciation is accelerated (due to higher replacement costs) whereas corporate earnings often do not keep pace--and the public is usually angry if they do.

A fourth issue that is examined is the question of institutional rigidities and resulting distortions of the free market mechanism for allocation of resources. On the national scene, the biggest single problem is the monopoly power of labor unions, which are frequently able to prevent technological progress in the short-term interest of their membership. Another key factor in the picture is the trend toward decisive intervention by the courts in the process of lawmaking. This tends to decrease the flexibility of the societal system, as a whole (notwithstanding the fact that "activist" courts began to intervene in the process of law-making because of unresponsiveness on the part of legislative bodies). Another key factor is the growth and proliferation of independent regulatory agencies. These bodies, too, effectively create law, although they are less immune from ultimate legislative review than the courts. Their future rule is currently being examined, after several decades of uninterrupted expansion.

The main overall effect of regulation on intercity transportation is to ensure that services are made available to many locations where demand would not otherwise justify such service. This policy has obviously increased costs to all users, particularly the larger cities. If regulation in the interests of small cities and rural areas were ended, their economic advantages vis-a-vis larger cities would largely disappear.

The fifth issue that is discussed in detail is the ongoing shift from extraction and manufacturing to the service sectors. This shift is most clearly documented in the declining relative importance of farming and "blue collar" jobs. However, there are less obvious trends which are no less significant. One important historical trend has been a shift away from some categories of services purchased direct from a central supplier, toward services provided by privately owned equipment. Thus rental housing has declined in favor of private housing, public transportation has declined in favor of private cars, commercial laundries have been largely replaced by privately owned washing machines, and commercial theaters have declined in favor of home entertainment (TV).

One reason for these substitutions is undoubtedly that tax advantages (especially interest deductions and depreciation) are available to those who "own" equipment that provides a service but not to those who merely rent the equipment or purchase the service itself. Changes in tax laws could affect these trends. Another key point, however, is that manufacturing the equipment that is used to substitute for formerly purchased services, has been a major area of industrial expansion in the last 30 years (single-family houses, cars, appliances). Many of these markets now appear to be approaching saturation. Communications, home electronics, and leisure/recreational markets are the chief exceptions. Undoubtedly leisure and recreational activities will continue to increase as a factor in demand for intercity transportation.

The final issue discussed in the paper is resource availability for the U.S. over the next 30 years. It is concluded that nonrenewable mineral resources are not likely to pose an insurmountable problem, due to the range of possibilities of recycling, stockpiling, and substitution. With respect to fossil hydrocarbons, of course, a problem obviously exists, and the U.S. will certainly be heavily dependent on foreign sources for at least 10 to 15 years, notwithstanding accelerated exploration for, and use of, coal. The consequence is almost certain to be permanently higher prices, and the era of "cheap" energy which the U.S. has enjoyed for several decades is probably over. If energy prices do drop sharply in the future, due to unforeseen political events (e.g., collapse of OPEC), the lower prices would be only temporary.

The impact of permanently higher energy costs on intercity transportation is clear in general terms: "energy intensive" modes (such as aviation and private autos) will suffer increased costs vis-a-vis their competitors (rail, bus). These increased costs will, of course, affect profits, prices, and levels of service and demand.

The Production/Consumption Duality

From the point of view of materials and energy, the economy is a system of transformations that convert raw materials and natural resources

(both renewable and nonrenewable) into "final" goods and services. This transformation is unidirectional: crude materials and energy are extracted, refined, processed, recombined in new forms, fabricated, and assembled into articles of commerce or "infrastructure." Value is added at each stage by human labor and the application of knowledge (technology). Ultimately, the manufactured products wear out or cease to be useful for some reason or other and become waste flows, returning to the environment. However, while materials are not physically lost from the universe--nor is energy--their form is irreversibly changed to some extent, and waste materials are intrinsically less recoverable (hence valuable) than the natural raw materials from which they were derived. Physicists call this gradual qualitative deterioration or aging process "increasing entropy."

However, classifical economic theory considers the economy to be a kind of perfect ageless machine. In this view, there is a cyclic relationshop between *production* or supply on the one hand and *consumption* or demand on the other. The "working fluid" of this machine is money, and money (like materials or energy) is subject to an accounting identity which is equivalent to a kind of conservation principle: for any nongovernmental economic entity, such as a household or firm, money inflows (income) must always be exactly balanced by outflows (expenditures) plus any changes in stock (savings or reserves). Governments, of course, can create new money by various mechanisms which complicate the picture, but this can be neglected for the moment.

The key point to be emphasized, for the moment, is the closed "cyclic" nature of the economic system: gross national product (GNP) is defined as the sum of all outputs by all producers (sellers) in the economy. But it is also (by virtue of the accounting identity) equal to the sum of all expenditures by all consumers (buyers) in the economy. Thus gross national product is necessarily equal to gross national expenditure.

A duality also exists between "costs" on the one hand and "prices" on the other. The cost of producing a given bill of goods (including services) consists of payments for purchased materials, capital equipment, interest and dividends on borrowed or invested money, taxes, and wages. Payments for purchased materials and capital equipment are, in turn, attributable to the same elements, in various proportions. Ultimately, all payments for products and services can be attributed to wages, rents, or other types of income to individuals.

Income, in turn, is allocated to savings (ultimately invested by financial institutions), taxes (government income), and private final consumption. The other categories of final consumption are government (public) consumption and investment (both private and public). Investment differs from consumption in that it is intended to increase the production of other goods and services. In practice, a further reason for distinguishing between consumption and investment goods is that

investment goods (except private housing, which could also very well be regarded as a form of investment) are also longer lasting on the average.

Consumption and investment expenditures for goods and services, in turn, provide the revenues (income) for producers. Revenue is, of course, the product of quantity times price, so prices are "costs" for consumers just as wages are "costs" for producers. This is the reason that raising wages without increasing production ultimately increases price levels.

The total *quantity* of goods and services produced (rather than their money value) is the true measure of economic performance. A major preoccupation of economists for the last two centuries has been to identify the critical driving forces--or constraints--on economic growth. At one time, there were serious doctrinal divergencies bewteen neo-classical, Marxist, and Keynesian formulations, but these arguments have been greatly muted* since the various theories were first put into clearly defined mathematical form and, especially, since the advent of serious large-scale statistical model-building in the 1930s. Today most of the so-called econometric "growth" models share a number of common features, though they differ in many details. They agree, in effect, that the overall driving force of the economy is aggregate demand, subject to the constraints of available labor and capital equipment. A soluble system of equations can be constructed from a suitable set of empirically derived relationships between consumption, investment, incomes, and prices, with suitable allowance for time lags. However, the correlations between variables become weaker as the time lags become longer; and in the long run, a system of econometric equations, alone, leads to an indeterminate future (i.e., all forecasting relationships have very low confidence levels).

The usual procedure to cope with this difficulty is to specify a number of "exogenous" variables--such as population, labor force, and productivity--whose growth is taken to be determined *outside* the model. In addition, it is enormously helpful to introduce structural relationships that can also be counted on to change slowly, if at all, over the time span of the projection.

The duality between supply/demand, production/consumption, or between purchases and sales provides a basis for just such a set of structural equations. These are the input-output equations which simply restate the accounting identities between monetary income and expenditure on a sector-by-sector basis. These equations can also be generalized to reflect *materials* and *energy* accounting identities. Most long-range economic forecasting models utilize a set of exogenous projections derived from other sources (or other models) and an input-output module to ensure that the stable balance of flows between production and consumption activities is maintained.

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*The arguments persist in the area of economic policy, however.

Factors Affecting Supply (Production)

Figure V-1 displays, in the form of a "contextual map," the key relationships between factors of production and gross domestic product (GPD).* Monetary flows, other physical flows such as population or construction, and regulatory influences (both direct and indirect) are illustrated. The basic theme of Figure V-1 is that production (GDP) is a function of two major factors, labor supply and capital stock. Each of these, in turn, has a physical and a nonphysical element.

The physical component of labor supply is *people*. The potential labor supply is not the total population, of course, since young children, elderly or incapacitated persons, students, soldiers and mothers with young children would be excluded. Some categories (such as students or military) are excluded by virtue of being otherwise fully occupied. Young children and elderly people are generally excluded by arbitrary age categories, as determined by law, employer policy, or by union contract. The period between entering and leaving the labor pool has progressively shortened over the years, with almost universal retirement by age 65 and "early retirement" options available to more and more people.

The size of the population and its growth rate are primary determinants of the size of the potential labor force. Growth rate is important because it fixes the *fraction* of the population that is in a dependent status and consequently not part of the potential labor pool. A slow-growing population has fewer children per adult, hence fewer adults required for child care than a fast-growing population. Differences can be quite significant. In 1971, only 42% of the U.S. population belonged to the labor force, but this will rise to 45% if the population follows the "D" Series and in the event of the "F" Series, as shown in Table V-1. Based on recent declines in the birth rate, the "F" Series is considered more likely. This means smaller families and more workers per unemployed child.**

Within these fixed age boundaries, however, there remains a sizable "gray area" with regard to the potential availability of mothers of young children and of various categories of handicapped persons. Women are having fewer children, and social attitudes towards women with children working outside the home have been liberalizing as more women

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*GDP is similar to the more familiar GNP, except that it *includes* foreign-owned output within the national borders and *excludes* the output of subsidiaries or activities abroad owned by domestic concerns.

**Of course the number of older and retired workers per active worker will increase; the number of retired persons per child below employment age will change most dramatically of all. Implications are discussed later.

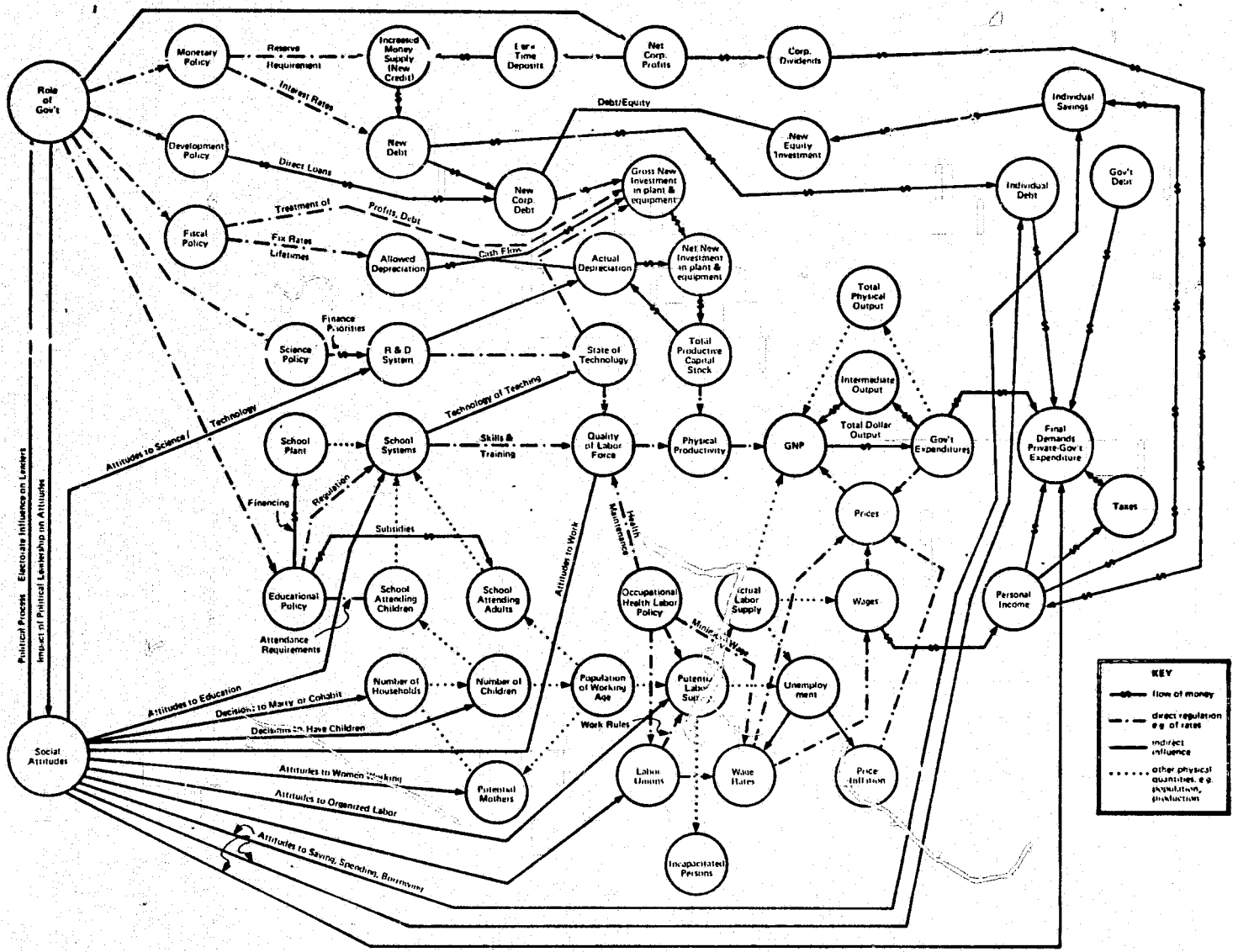


Figure V-1. RELATIONSHIPS BETWEEN FACTORS OF PRODUCTION

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Table V-2

POPULATION GROWTH AND LABOR FORCE

Series	Population			Labor Force			Ratio LF/Pop		
	D	E	F	D	E	F	D	E	F
1971	--	207.0	--	--	86.9	--	--	.420	--
1980	228.7	224.1	221.8	101.1	101.8	102.2	.443	.454	.451
1985	243.9	235.7	230.9	106.5	107.7	108.2	.437	.458	.433
1990	258.7	246.6	239.1	112.1	112.6	113.0	.433	.458	.473
2000	286.0	264.4	250.7	128.1	124.3	122.3	.448	.470	.488

Source: Jack Alterman, Resources For the Future, Inc.

take up careers. Increasing efforts are likely to be made to assist mentally retarded, blind, deaf, or partially crippled individuals to find useful work. Thus, a larger percentage of the "potential" labor supply between school and retirement ages will be participating in the future.

The nonphysical component of the labor supply is its "quality." This is partly a matter of adequate physical health--now essentially assured for most persons in the working population in the U.S. and other developed countries--partly a matter of basic education plus specialized skills, and partly a matter of attitudes on work. Health and education are largely resultants of public sector activities. (The schools are the biggest single user of tax dollars in the U.S.) Even attitudes on work are heavily affected by the external (i.e., school) environment, though parents are probably still the dominant influence. Thus, the *quality* of the U.S. labor force in the future is highly dependent on the effectiveness of public policy in these areas.

Technology clearly has some influence on the "quality" of labor.* Technology which simplifies certain activities--thereby making them easier to grasp--will have a beneficial effect. For instance, the slide rule, and more recently, the pocket calculator, have unquestionably increased the number of people who can deal with elementary mathematical problems

*To this extent it can be said to be "embodied" in the labor.

in a practical context. Similarly, the electric typewriter has undoubtedly simplified the process of learning to type, etc. The major justification for Henry Ford's innovation of the "production line" was to permit semi-skilled workers to accomplish tasks that had formerly required highly skilled and experienced craftsmen. Thus, Ford was actually able to train new workers "on the job" and, consequently, to expand production rapidly.

The second factor of production indicated in Figure V-1 is capital stock. In the example given above, Ford's technology also *replaced* human labor with that of a machine. The machine represents capital, and the technology is also, to an extent, embodied in the capital equipment. Capital equipment is itself the product of labor, technology, and capital. In principle, then, one might treat capital as a derivative quantity (rather than a basic one) and eliminate it, thus regarding capital as "congealed" labor and technology, as in the Marxist labor theory of value. But it is equally reasonable to regard products intended for consumption in this way, and the labor theory of value smudges over the critical difference between capital goods and consumption goods, namely, that the former produce *more* goods and the latter do not. Further, capital stock--like labor--has a qualitative aspect as well as a quantitative one. Embodied technology is the "quality" of capital.

Although some economists have engaged in controversy as to whether technology "should" be regarded as embodied in labor or in capital, it seems unnecessary to pose such a question. In specific circumstances one or the other statement might be true, but neither is true under all circumstances. Furthermore, technology--including the technological component of capital--cannot be simply regarded as a "form" of accumulated labor. While some kinds of human knowledge do require much labor (or analysis) to acquire--e.g., detailed measurements of properties of materials, etc.--the *synthetic* content of technology is simply not measurable in terms of "man-hours" of inputs. Critical insight might occur in ten seconds or ten years or ten centuries, and technology is, if anything, the result of an accumulation of many insights into the relationships between the characteristics of materials and the forces of nature. Thus, it is most realistic to regard technology as an independent factor of productivity.

As noted, there are situations where technological changes influence the pattern of consumption, hence of production, without being embodied in either labor or capital. Product design is an obvious case in point. Design improvements resulting from new technology may make it possible to fly a plane faster, to use less fuel, or both. These changes will increase the quality of service rendered to the final consumer. They will also certainly increase the share of airlines in the total transportation market (at the expense of other modes).

Let us now regress one step further in the chain of causality and ask the question: What further factors can be expected to influence

capital investment in quantitative terms? And what factors will affect *technology* in its triple role as determinant of quality of labor, quality of capital, and quality of product and/or service? These topics are discussed in later sections.

Factors Affecting Demand (Expenditure)

Figure V-2 displays, again in the form of a contextual map, key relationships between elements of demand. As before, monetary flows, physical flows, direct regulatory influences, and sociological or other influences are illustrated. The purpose of the chart is to display some critical interactions and relationships.

One of the important "feedback loops" in the chart connects private purchases of durable and nondurable goods and services to investment in nonhousing capital stock. Simply, the greater the demand for such goods and services, the greater the required output of the industry, and the greater the resulting capital investment.

Another, less well-known feedback loop is the connection between the *stock* of consumer durable goods such as housing or cars, and the consumption of goods and services needed for operation and maintenance purposes. For instance, cars and car owners require gasoline, tires, batteries, spare parts, and highway maintenance not to mention insurance, motel accommodations, bridge/tunnel tolls, traffic police, etc. Thus, current *sales* of all these goods or services will tend to depend upon the current *stock* of passenger cars (other factors remaining equal). Similarly, houses and their owners demand furniture and furnishings, appliances, paint, hardware and cutlery, heating fuel, electricity, water and sewage service, lawn and garden care equipment, etc.

For expenditures on housing and durable goods per se, another factor must be considered. Demand can be subdivided into *replacement* and *additions to stock*. Generally speaking, different economic factors come into play in the two cases. Replacement demand is determined by the size of the existing stock, and the rate of depreciation, which is a complex function of "intrinsic" depreciation rates, repair/renovation costs, and demand for second-hand units. For housing, depreciation of structures is often offset by appreciation of underlying land values (e.g., in growing suburbs). Less commonly, land values may depreciate sharply due to shifts in local racial balance, removal of desirable amenities, or location in the areas of "undesirable" activities (e.g., prisons, waste processing sites, industries generating heavy vehicular traffic, etc.).

Demand for addition to a "stock" of durables, on the other hand, is typically triggered by increases in population, or income per capita, as well as "consumer confidence." During times of economic expansion and optimism, people are more likely to go into debt to purchase durable goods (on credit); conversely, during recessions or periods of

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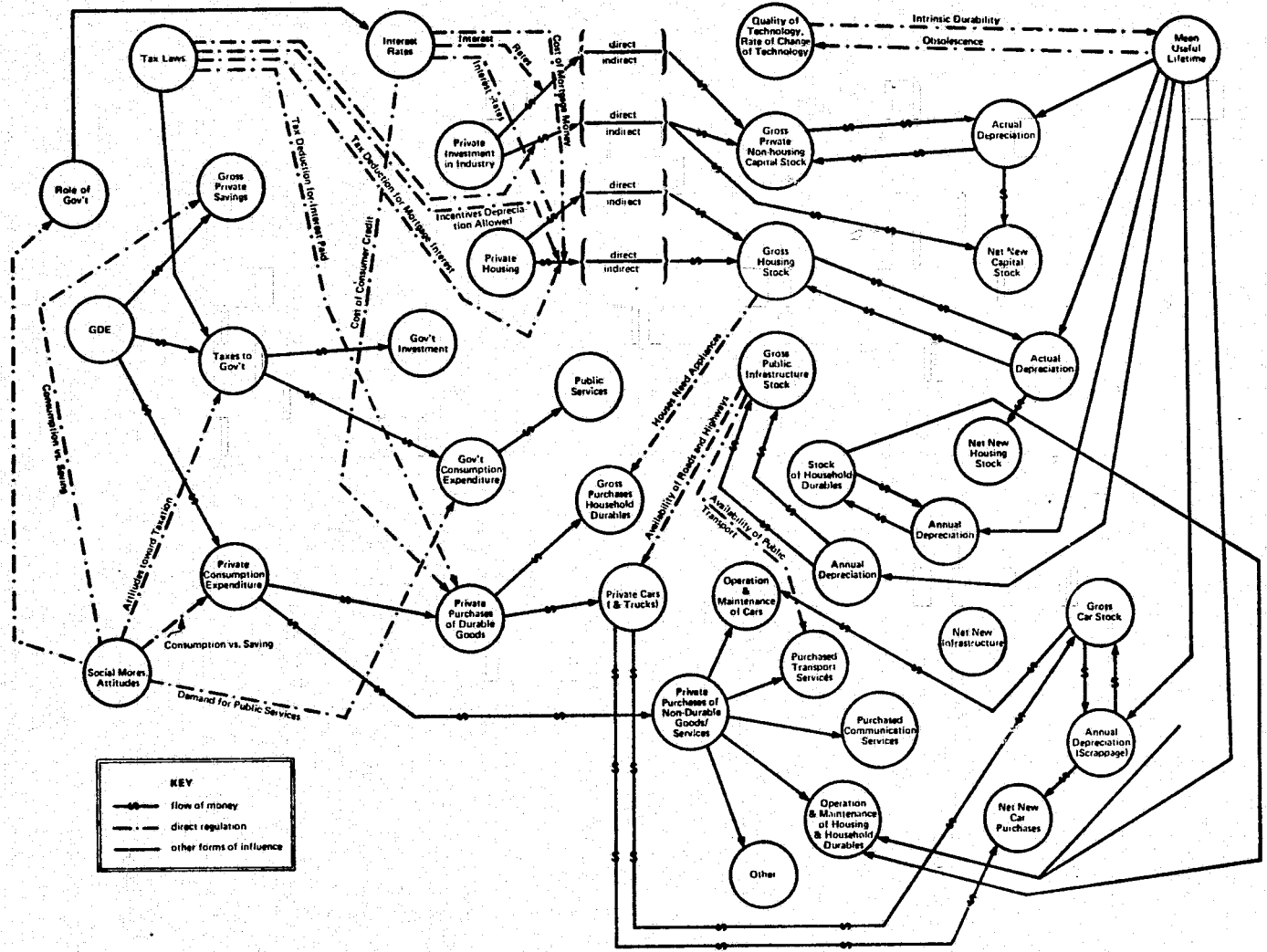


Figure V-2. RELATIONSHIPS BETWEEN ELEMENTS OF EXPENDITURE (in equilibrium)

uncertainty, there is a greater tendency to liquidate debt and build up cash reserves or savings. Unemployment is a reasonably good surrogate variable for consumer confidence; when unemployment is high, confidence is likely to be low, and vice versa.

It follows from the above, that recovery from a slump tends to be "self-propelled" (during the earlier stages, at least) as increasing prosperity leads to increasing demand which, in turn, cranks up the economic machine to a higher level of activity.

However, there is an upper limit (already noted) imposed by the fixed available supply of labor and capital goods. As the existing capacity to produce goods and services is approached, spot shortages--bottlenecks--begin to develop here and there. As capacity utilization increases further, the competition for labor and goods becomes more intense, resulting in bidding up of wages and prices of certain commodities. As these price rises are propagated through the economic system to final goods and services, they soak up consumer buying power and begin to "damp" the expansionary impulse initiated by increased demand. Thus, the boom ends.

The economic deceleration process is also self enhancing, at first, as decreased consumption results in decreased production, followed by layoffs, idle capacity, and unemployment. The sequence of "boom," followed by "bust" is the so-called business cycle. The basic principle of Keynesian economic policy is to curb these disruptive oscillations by introducing expansionary influences (e.g., deficit spending) during recessions, while deliberately deflating booms by cutting back on government spending and raising taxes or interest rates. The art of fiscal and monetary intervention is optimistically known as "fine tuning" the economy. In practice, however, it is politically more difficult to exercise fiscal or monetary restraint than it is to promote expansion. Moreover, the econometric "growth" models which were supposed to provide precise guidance as to timing and magnitude of the appropriate stimuli have been proven by recent events to be much less reliable than had been supposed. Hence, it is not likely that economic growth in the U.S. can be sustained on a steady basis over the next two decades, without sharp corrections from time to time.

Indeed, many economists fear that cyclic ups and downs may be magnified in the next two decades due to the increasing integration of the world economy. In previous business downturns, there has been a "phase-mismatch" which sometimes enabled countries to cushion the impact of falling domestic demand by increasing exports, and conversely, to increase imports during times of excess domestic demand to reduce the inflationary effect. One of the major world economic problems for the next three decades is the lack of an adequate international mechanism for economic management, particularly of the world monetary system. It is not clear at present how this problem can be resolved, if at all.

Capital Requirements/Availability

One of the major questions troubling economists, currently, is whether the U.S. is facing a capital shortage of major proportions. Among those who "view with alarm" are Secretary of the Treasury Simon; James Needham, the Chairman of the New York Stock Exchange; Henry Wallich of the Federal Research Board; and R. H. Jones, the Chairman of General Electric Company. Some points worth considering in relation to this topic include the fact that the U.S. has invested a smaller proportion of its GNP in new plant and equipment (from 1960 to 1973) than any other major industrial country--only 13.6% as compared to 29% for Japan and 20% for West Germany.* As a result, the U.S. capital stock is aging and obsolescent. Major industries such as steel and automobile manufacturing must invest enormous sums in the immediate future to upgrade their production facilities and reduce unit costs in order to meet foreign competition. Many industries will also require significant new investment in pollution abatement facilities during the next decade. This "catch up" requirement coincides in time with the very large anticipated new capital requirements for coal gasification, nuclear power plants, urban mass transit, and other technologies that are more capital-intensive than their predecessors. As will be noted in a later section, the quality of ores now mined has sharply declined in the past few decades, requiring correspondingly increased materials handling, waste disposal, and energy inputs for processing the ore.

Recent inflation has aggravated the undercapitalization problem by increasing the cost of replacement and hence the *effective* rate of depreciation; cash flow generated by *allowable* depreciation is unchanged and hence increasingly inadequate. Inflation also creates spurious "inventory profits" which add to apparent earnings and, consequently, are taxed. Since the inventory and capital equipment must later be replaced at higher prices, the taxation of inventory profits is effectively a tax on working capital.

The problem can be viewed, too, in terms of the drying-up of traditional sources of funds for investment in productive capacity. The generally poor performance of the stock market since the early 1960s has diverted new investment funds from equity issues into fixed income securities. Some of these debt instruments represent investment, but government debt accounts for much of this. There is an increasingly popular theory that funding of government securities effectively "crowds out" the private sector in competition of funds. Declining equity share prices also represent a decrease in liquid assets (which can be used as security for bank loans, for instance). The wave of conglomerate mergers in the late 1960s resulted, in many cases, from artificial "pumping up" of apparent earnings by essentially unproductive gimmicks such as changes in

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*H. L. Leibling, J. Jaakson, U.S. Department of Treasury (*Washington Post*, April 7, 1975).

accounting methods, "spinning off" of real estate assets, reducing contributions to pension plans (by "assuming" more favorable earnings from existing funds), etc. These reported "earnings" were taxed at current rates, thus effectively draining off potential assets (or, equivalently, creating future liabilities). Now the adverse effects of these manipulations are being felt in terms of excessively low price/earnings ratios and resulting inability of corporations to find equity capital.

An excessive amount of money in the U.S. has also been invested in land speculation, by individuals and by institutions, due to favorable tax treatment. Profits from rising land prices do not represent "real" economic growth, however, but essentially detract from it by diverting capital funds away from productive purposes. (The same can be said for other "exotic" investments, e.g., gold, works-of-art, etc.) It should be noted, incidentally, that the U.S. is unique among developed countries in encouraging land speculation by permitting virtually uncontrolled real estate development--much of which consists of nothing more than subdividing large pieces of land into small parcels for resale to the public. This, too, has diverted funds away from productive investments.

There are arguments against the "shortage" hypothesis that deserve consideration. One key point is that some of the projections assume new capital requirements (to provide substitutes for costly Arab oil) will be superimposed on capital requirements for electric power generation based on pre-1973 projections of electricity consumption. Since the price of oil has risen so sharply, electricity prices have also shot up and demand is sharply down. Based on pre-1973 prices and trends, electricity consumption was expected to double each decade, for an eight-fold increase between 1970 and 2000. Capital requirements would increase as much--or more--since nuclear power plants require more capital per unit of capacity than conventional (steam) plants.

On deeper analysis, however, demand for electric power--like other goods and services--is clearly a function of population growth, income, price, and other factors. Past demand growth is partly due to growing personal income, partly due to increasing population--the post-World War II "baby boom"--and partly due to the declining price of energy (in real terms) from 1950 to 1970. The large bulge in single-family housing construction is also a major factor. The relative importance of these factors can be estimated by multiple-regression analysis of demand statistics. Assuming merely that population growth continues along the present track (Census "F" series), and that the "real" cost of electricity rises at 3.3% per year, the total demand for electricity would increase by only about 31% between 1970 and 2000 (see Table V-2). Thus, the capital *not* needed to build electric-power-generating facilities would be available for coal gasification or shale oil recovery.

Slower population growth also implies less need for schools, another major user of capital in the last two decades. School populations are

Table V-2

U.S. ELECTRICITY CONSUMPTION PROJECTIONS, VARIOUS CASES (10^{14} kwh)

Assumptions		Year 1970	1980	1990	2000
Population continues to increase at 1.1% per year (Census "D" Series)	1. Simple extrapolation of past demand (7.35%/yr)	1.53	3.05	6.10	12.20
	2. Real costs *decrease* 24% from 1970 to 1980, 12% per decade 1980-2000	1.53	3.05	5.66	9.89
	3. Real costs remain constant 1970-2000	1.53	2.54	3.56	4.56
	4. Real costs increase 19% 1970-1990; constant thereafter	1.53	2.38	3.01	3.45
	5. Real costs increase 3.3% per year; double by 2000	1.53	2.07	2.11	2.01
Fertility remains at zero and population growth ceases by 2035	6. See #4 above	1.53	2.37	2.95	3.29
	7. See #5 above	1.53	2.05	2.07	1.91

Sources: IRT-331-R, "Economic and Ecological Consequences of Changing Patterns of Energy Production and Utilization: Overview," December 31, 1973. Data taken from D. Chapman, T. Tyrrell, and T. Mount, *Environment*, Vol. 15, No. 8, October 1973.

now peaking and beginning to decline; hence much less new construction will be needed in the future than in the recent past.

Similarly, while urban mass transportation and railroads are expected to absorb a good deal of capital over the next two or three decades, this would largely be in place of highways. The national highway system is in much better shape than rail-based systems, and additions to it will be limited and selective. Despite fanatic defense of the "highway trust fund" in Congress, the handwriting is on the wall: the fund will soon either become a general transportation trust fund or disappear altogether.

Finally, slower population growth, smaller families, high land costs, and high energy costs will probably put a permanent end to the suburban growth boom. Multiple-family dwelling units and higher density land use will be the prevailing rule. This trend will result in substantial capital savings per net new housing unit, especially in terms of roads and utility services. The spread of population to the suburbs diverted immense amounts of capital into duplicating (at low density) facilities that already existed in the higher-density central cities. For the rest of the century, however, the rate of building of new public facilities of many kinds can be cut back substantially without penalty. This will free capital for investments that have been neglected in the recent past, such as water and waste treatment.

The major factors affecting capital availability are graphically displayed in Figure V-1. They are, primarily, elements of government policy and public attitudes:

- Monetary policy
- Development policy
- Fiscal policy
- Public attitudes toward business, as translated through the political process into regulatory policy
- Public attitudes to private spending, saving, and borrowing

The impacts of monetary and fiscal policy are probably the most potent. Monetary policy determines interest rates and the lending power of banks (through control of reserve requirements). Fiscal policy determines the relative attractiveness of various means of financing. The "cost" of capital to business is dividend and interest payments. Corporate profits (from which dividends are paid) have dropped by 50% from 1966 to 1974 in real terms, while interest payments have risen even more sharply as both the quantity of corporate debt, and interest rates, have risen. Current tax policy permits interest payments, but not dividends, to be deducted from taxable income--though both are payments for the use of money. Hence, a corporation must pay about $1 in taxes

for each $1 paid in dividends. Thus for corporations--like homeowners--it pays to borrow, even at high interest rates, as long as the money can be put to good use.

Of course the emphasis on borrowing--as opposed to issuing new equity shares--eventually creates its own risks and limits. Many banks were facing severe liquidity problems a year ago because of potentially bad debts; some debts were written off, and many repayment schedules were stretched out as the only alternative to bankruptcy. The capability of commercial banks to provide needed new capital is clearly limited, but changes in the existing tax laws may be required before the equity capital market can be expected to supply any significant amount of investment funds.

Public attitudes to business are highly relevant, here. At present, there is little public understanding or sympathy for the role of profits and dividends in generating capital funds for economic growth. Indeed, public attitudes toward business have been increasingly negative over the past decade or more, for a variety of reasons. Evidence of increased "social consciousness" on the part of business leaders would undoubtedly do much to help, but better understanding of basic economic issues on the part of the general public is of paramount importance. If present trends continue, the public--as represented by its legislators--will continue to pile regulations and penalties on business, while criticizing "excessive" profits without understanding that profits are needed to pay dividends, which are, in effect, the "cost" of equity capital, which is the base of the pyramid. Without an equity base for security, debt capital is not available. Under these circumstances, the only viable alternative source of capital funds is direct government investment. Increasing government intervention in the capital markets, as *lender* and ultimately, perhaps, *owner* of industry is therefore a not unlikely eventuality for the U.S.--despite current reflexive rhetoric denouncing socialism.

With regard to intercity transportation, it is clear that a capital shortage would operate primarily to retard the development of high-speed rail links--which would require substantial rebuilding of existing lines--and favor modes utilizing the Interstate System of highways, which is already largely in place.

Productivity and Technology

The root causes of productivity growth--apart from obvious quantitative inputs noted already--are not well understood at present. There is fairly wide agreement among economists that the rate of growth is likely to decline, rather than increase, in the next quarter century. Reasons frequently cited include allegedly deteriorating work habits (over-education?), shifting social values that emphasize distributive justice or "quality of life" more than wealth or standard of living as traditionally measured, and declining relative importance of the extractive

and manufacturing sectors where physical measures of output are easily monitored vis-a-vis "service" sectors whose outputs are difficult to measure. It is difficult to determine the educational product generated by a given educational system; hence, the output tends to be measured simply in terms of the inputs (costs, number of teachers per student, etc.). The same problem clearly applies in many other service areas, such as health, law enforcement, and general government. Real productivity may be increasing or decreasing in these sectors, but it is evidently not measured adequately.

Less familiar arguments on productivity growth in the future can also be cited. One interesting argument is based on the notion that productivity growth is the ultimate measure of a society's ability to absorb social and technological change. Output per unit of input cannot increase *unless* the method of production, i.e. the technology, is altered in some way. Secular education has social functions above and beyond the inculcation of job skills; it imparts some degree of understanding of the relationships between historical past and actual present, between one culture and others. It sensitizes people to the existence of possible alternatives and to the fact that societal changes can and do occur and may be beneficial, and it provides a necessary antidote to the fear of change which characterizes most human conditions and cultures.

The dramatic productivity increases in Europe and the U.S. in the 18th and 19th centuries were undoubtedly made possible by the combination of urbanization and general education of the population. Without these sociological factors, machinery alone would have had little impact because people brought up in "traditional" peasant or village cultures are generally antagonistic to machines and mechanization--and, indeed, to any kind of innovation.

Institutions in the modern world are, also, often resistant to change and the increasing concentration of industry is widely regarded as being antithetical to rapid innovation. However, it would be unduly pessimistic to assume that productivity growth will slow down based on this factor by itself. Innovation, itself, has become institutionalized to a significant degree. For instance, most large firms have evolved a "new product cycle" which begins in the corporate R&D laboratories and ends with coordinated manufacturing and marketing. A steady flow of new products is needed to replace existing products that gradually become obsolete and to engender expansion. Insofar as firms (and governments) are organized around the goal of internal growth and expansion, they are inevitably concerned with promoting innovation both internally and in the marketplace.

As noted already, the educational system supports this societal inclination toward "growth" by teaching people to expect change and even glorifying technological and socioeconomic progress. The communications media are potent tools of education and indoctrination, especially television, which has proven to be highly effective for purposes of

advertising. A new product, service, or technique can be introduced nearly instantaneously to virtually the whole population in a technologically sophisticated Western country--whereas new ideas percolate very slowly in a village-oriented society such as India. In these terms, modern technology has done much to increase the rate at which still newer technology can be absorbed; i.e., the rate at which the society itself can be changed.

Indeed, the true potential of electronics and telecommunications technology for upgrading education and diffusing knowledge have only begun to be realized even in the U.S. Similarly, the potential for computer control of productive processes and automation of factories is only now beginning to have a major impact in most industries. Computerization to date has primarily affected accounting, information processing and scientific/engineering activities. The large-scale use of computers to control *physical production* will probably begin in the 1980s.

Notwithstanding the negative social factors, such as job dissatisfaction, social malaise, and the decline of the work ethic--elsewhere cited as reasons for assuming an economic slowdown--the technological factors suggest just the opposite conclusion: when the current economic readjustments and shakeouts have run their course, the possibility exists for an even more dramatic period of economic growth than the 1950 to 1970 epoch. If this does not occur, it will be for reasons of a political and macroeconomic nature--notably, the extent to which the growing conflict between unemployment and inflation is managed over the next two decades (this is discussed next).

It is worth noting that the same technological factors which appear to be ready to produce a major increase in productivity on the national scene, are also applicable to intercity transportation modes in particular. For instance, major improvements in air traffic control appear to be forthcoming in the next decade, and automated baggage handling, train control, track monitoring, loading/unloading, and rail car switching are also technologically possible. The major impediment to implementation (apart from the problem of capital availability) is the likelihood of union resistance.

Unemployment vs Inflation

The greatest puzzle confronting macroeconomists and economic policymakers today is the nature of the relationship between unemployment and inflation. That a close relationship exists was suggested by the English economist A. W. Phillips.* Phillips postulated a fixed relationship

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*A. W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kindgom, 1861-1957," *Economica*, November 1958, pp. 283-299.

illustrated in Figure V-3 expressing the observed tendency of inflationary pressures to rise as unemployment decreases.

In recent years, it has become evident that the notion of a fixed relationship is inadequate. Crudely, the equilibrium value of unemployment corresponding to a given level of inflation appears to have been rising. Or, putting it another way, the "equilibrium" level of inflation for a given level of unemployment has been increasing.

The connection between the two phenomena is, in simple terms, a consequence of the nonhomogeneity of the labor market. As the economy as a whole approaches full capacity, some industrial sectors and some occupational specialties reach and exceed nominal capacity before others. At this point, prices and wages begin to rise under the pressure of demand because some marginal users of the product or service that is in short supply must be knocked out of the "queue." The marginal users will turn to less satisfactory substitutes (thus propagating the excess demand to other sectors), while the successful bidders will pay more, and--in a tight market--pass the higher wages and prices they pay to their own customers. Since the extra payment did not actually purchase more goods, but merely served as a "rationing" device, the net result is an increment of wage/price inflation. As more and more sectors or specialties reach the point of full capacity, of course, the greater the inflationary impulse.

An important complicating factor in the picture is that certain specialized sectors have achieved legalized monopoly status which permits them to artifically restrict supply and force up prices (or wages) to high levels. Craft unions and certain professions (e.g., doctors) are the most noteworthy examples in the U.S.

Why should the balance between unemployment and inflation shift markedly over time? An institutional answer might be that the economy is growing more complex and more rigid, and the elasticities of substitution between commodities, between occupational specialties or even between capital and labor (in the short run) are becoming progressively reduced. Union strength, concentration of industry, and government regulation all may contribute to this inelasticity. Marxist economists find an explanation in the growth of capital investment per worker which, they argue, leads inevitably to a falling real rate of return on capital investment. This follows from the Marxist doctrine that capital was created by workers' "surplus" labor, where workers are entitled to appropriate all productivity gains to themselves as higher wages.

One need not accept the Marxist labor theory of value to accept the historical fact that returns on capital investment have in fact been falling sharply for most of the decade since 1965 (see Figure V-4). During this period, workers have consistently received wage gains greater than the increase in real productivity, resulting in a declining share for investors. Yet real average wages did not increase during most of this decade and are now actually below the 1965 level, as shown in Figure V-5. Thus workers in the aggregate gained nothing by

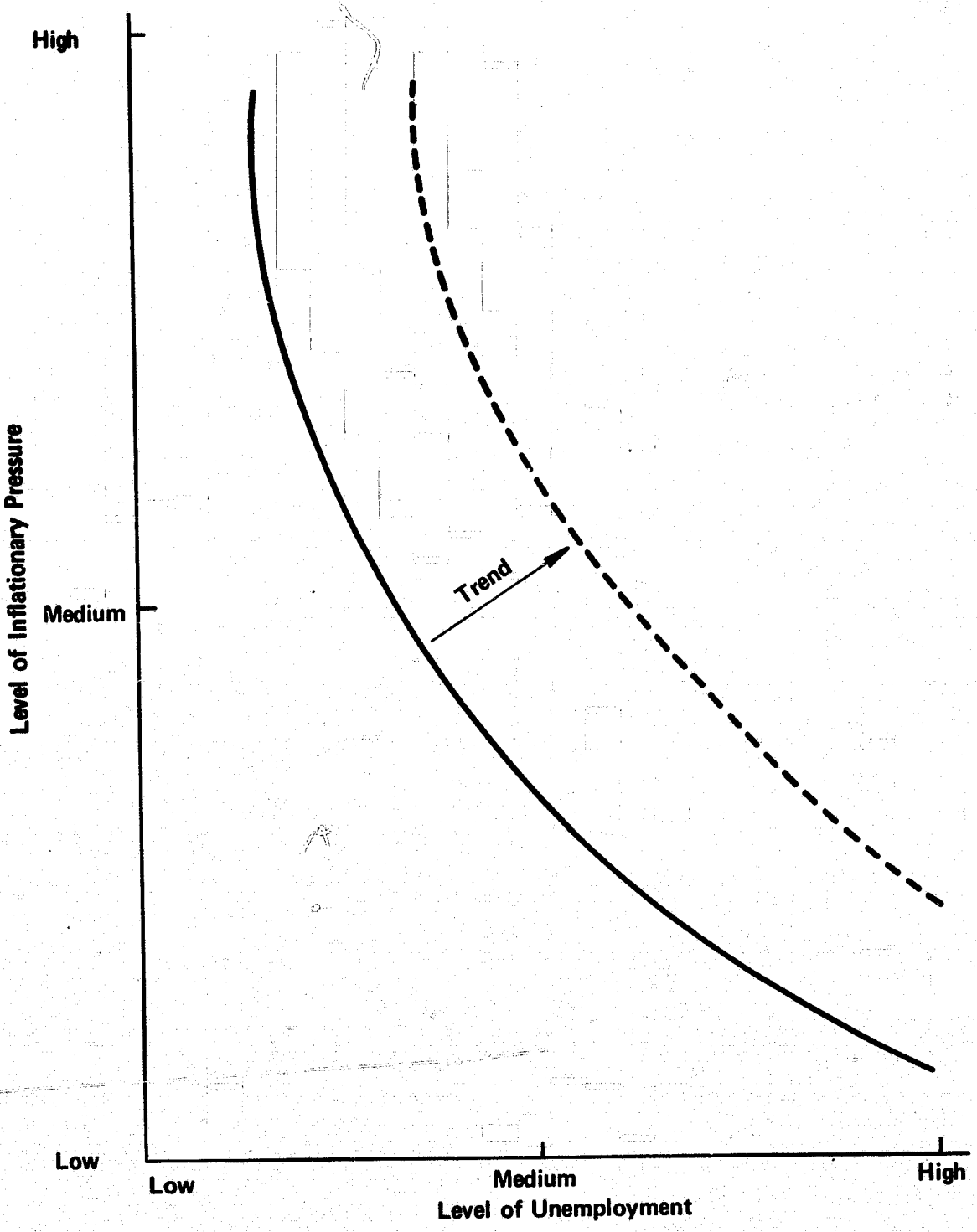


Figure V-3. PHILLIPS CURVE

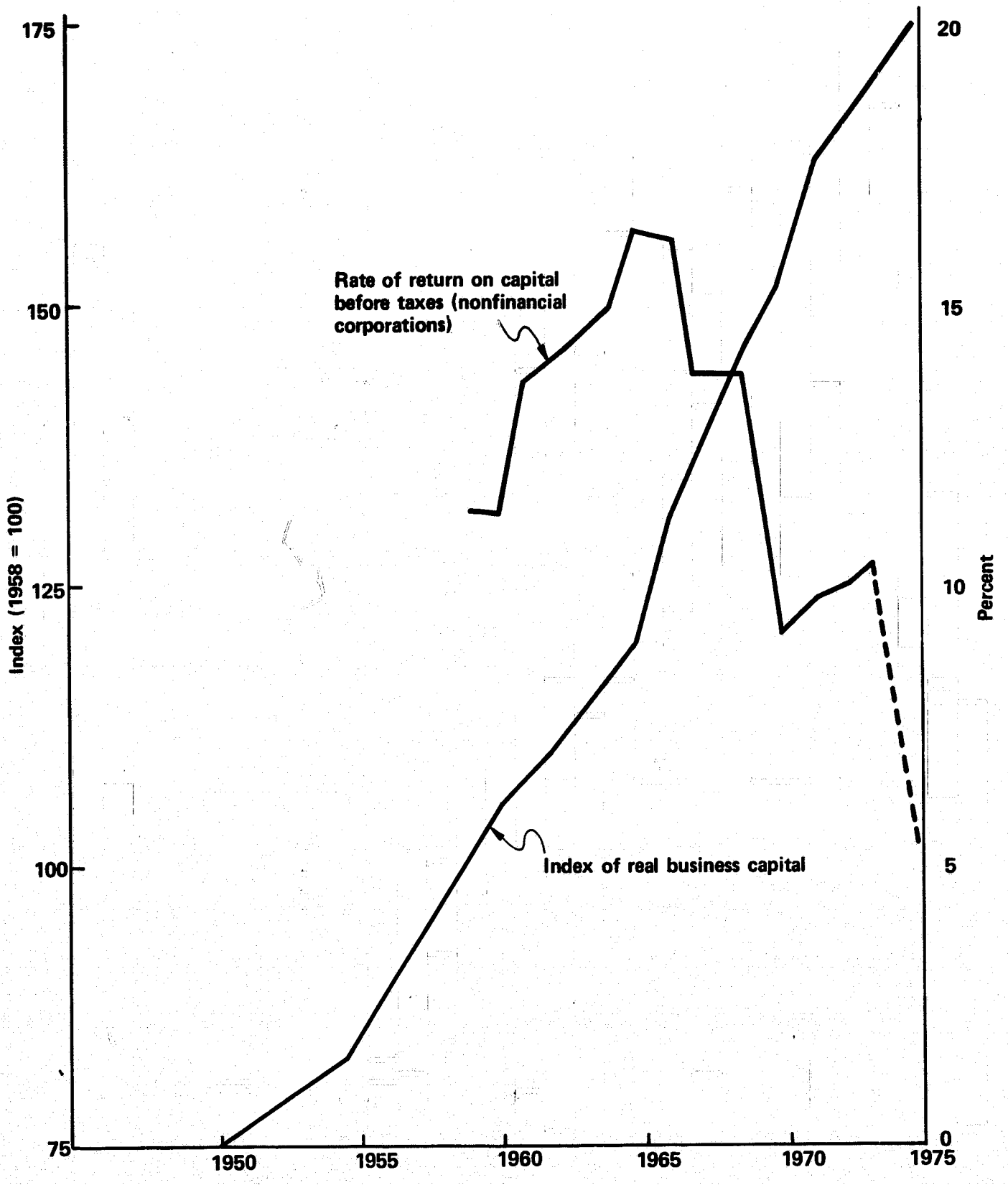


Figure V-4. TREND IN RETURN ON CAPITAL INVESTMENT

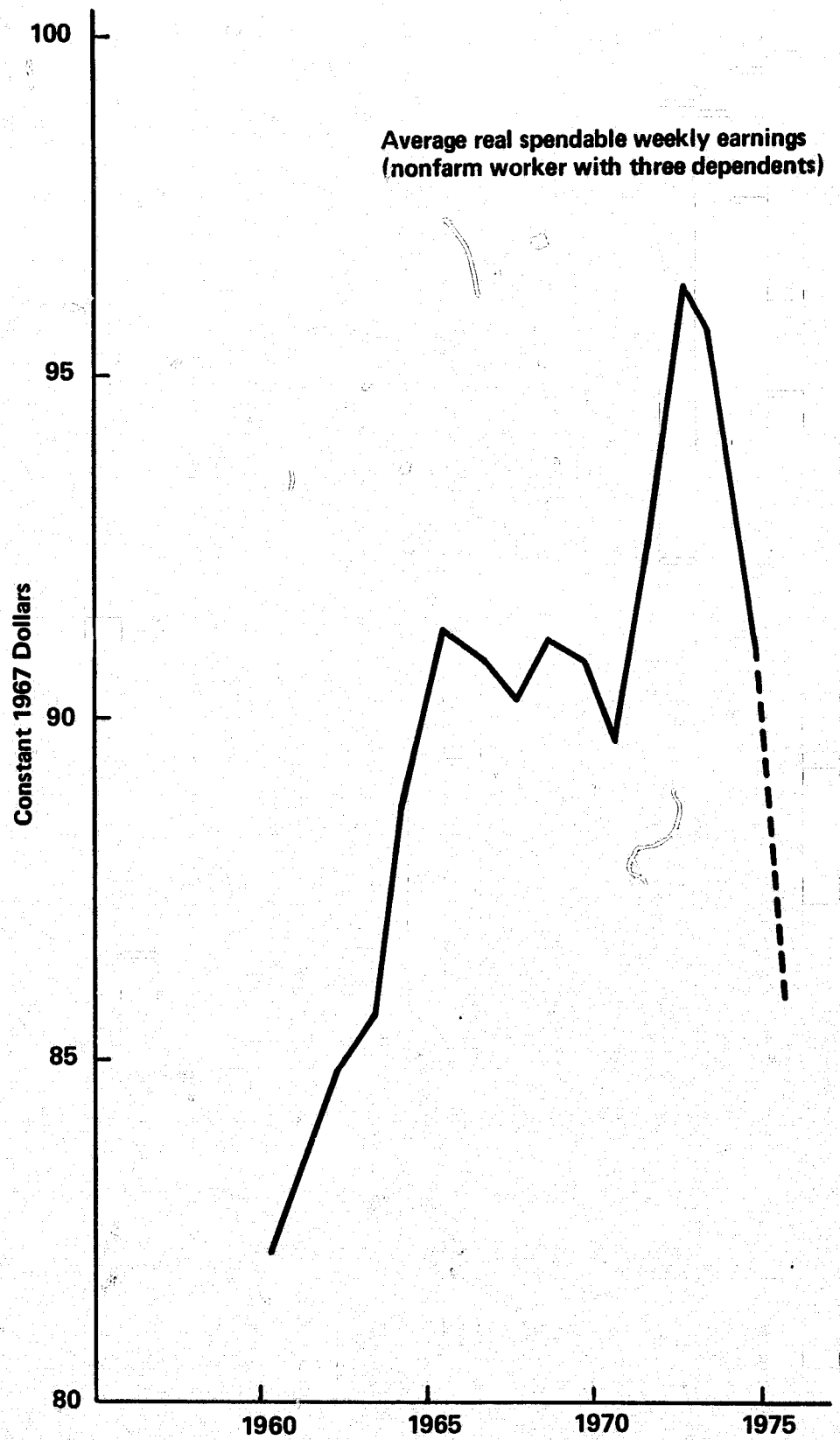


Figure V-5. TREND IN REAL SPENDABLE EARNINGS

increasing wages at the expense of profits, because economic growth suffered. The necessary function of the recession--(or "crisis of capitalism" in the Marxists' view)--is evidently to purge the economy of accumulated imbalances and, especially, to weaken the resistance of organized labor to innovations that will increase the productivity of, and return on, existing capital(i.e., achieve greater potential output from the same physical plant and a smaller labor force). When this occurs, the necessary conditions for a new long-term capital spending boom would presumably recur, since aggregate demand could then be safely pumped up by government spending without immediate risk of encountering capacity limits in either labor or capital.

A key question for the future is the extent to which organized labor will continue to be able to preempt all productivity gains--and more--thus creating short-term inflationary pressures while simultaneously undermining the basis for long-term productivity increases. The answer to this question depends on the next set of issues, namely the role of institutions in U.S. society.

Institutional Rigidities and Market Distortions

All of the factors that directly affect economic growth and change are likely to be significantly influenced by changing political, legal, regulatory, and "structural" conditions. Only a few specific topics can be touched on lightly in a paper of this scope.

In the light of the foregoing discussion of inflation, it is clear that organized labor has achieved monopoly power in certain sectors (especially craft unions) which contributes to inflationary pressures. Indeed, all unions are monopolistic to some degree, and most unions use their power to artifically restrain competition (e.g., for jobs) and to restrict technological innovation. In some instances--for example, the printers union in New York City, the longshoremen, seamen, and railway unions throughout the U.S.--union resistance to change has had disastrous consequences for the industry. In other cases, such as the coal miners, unions have been more amenable to permitting technological progress.

The power of unions to restrict supply and hold back innovation depends ultimately upon their legal status and internal organization, as well as the attitudes of society toward organized labor. As long as they are permitted by society to do so, of course, unions are able to cut off critical inputs or services to back up their demands. In the U.S., union power is significantly limited, due mainly to the Taft-Hartley law. But under the "interstate" provision of the Constitution, this law does not apply--for instance, to municipal unions (e.g., in New York City). More fundamentally, union monopoly power depends on being exempt from application of antitrust laws. This exemption could be removed legislatively or--conceivably--by constitutional challenge in the courts. In recent months, the Supreme Court has already

significantly reduced the scope for exercise of union power through secondary boycotts and other devices.

A second broad trend that has taken shape in recent years is the tendency of the judicial and regulatory systems to take over significant legal functions that would once have been considered to be in the legislative domain. Courts increasingly intervene in areas of substantive policy-making from pollution abatement and land use to school financing and pupil allocation. This has happened as a consequence of the inability or unwillingness of elected legislative bodies to deal with problem areas where existing law failed to satisfy constitutional requirements.

However, "law" that is made by the court is virtually impossible to change, except by a higher court, after a lengthy review process. Long-range unintended side-effects may be quite serious in some cases. One consequence of the court-imposed school desegregation process within cities is that local neighborhood high schools have become citywide in coverage. Court decisions predicated on constitutional guarantees of equal treatment have imposed (or might impose) onerous financial requirements such as duplicate classroom facilities for Spanish-language students. The "track" system in the District of Columbia, which segregated students by ability, was abolished by court decision--and most white parents withdrew their children from the public schools or moved completely outside the boundaries of the District. To give examples from another field, courts have repeatedly struck down local attempts to legislatively control the direction of economic and land use development at the local level. Long-term consequences of these particular decisions are perhaps only marginally relevant here. More important, however, is the long-term trend toward increasing interference by the courts in formerly legislative matters. This will inevitably increase the rigidity of the societal structure--which is ironical, in view of the fact that court intervention has frequently occurred because of unresponsiveness on the part of the legislative branch of government to needed changes.

Another marked trend is the accumulation of power by so-called "independent regulatory agencies" such as the Federal Reserve Board, Securities and Exchange Commission (SEC), the Federal Trade Commission (FTC), the Federal Communications Commission (FCC), the Federal Power Commission (FPC), the Interstate Commerce Commission (ICC), the Civil Aeronautics Board (CAB), the Federal Energy Administration (FEA), the Nuclear Regulatory Commission (NRC), the Environmental Protection Agency (EPA), and the Consumer Product Safety Commission (CPSC). These agencies and their state counterparts determine interest rates and reserve requirements for banks, allocate routes and fix rates for transport companies, allocate territories for radio and TV stations, fix rates and territories for electric and gas utilities, fix telephone rates, fix wellhead prices for natural gas and petroleum, fix priorities for allocation of energy fuels among users, fix allowable emissions, formulate rules governing public disclosure of financial information and sale of securities, govern forms of advertising, govern terms of

competition among regulated utilities, impose safety requirements for nuclear power plants, etc. Obviously large sectors of the economy are no longer operating in a free-market environment, either domestically or internationally.

Specific examples have been cited in the press tending to suggest that all of this "defensive" regulation is extremely costly to the economy by restricting competition and prohibiting changes that would increase output. For instance, railroads and airlines have been restrained from offering the cheapest possible service in some instances, while being forced to provide money-losing services in other cases.

Regulation, taken as a whole, tends to slow down the rate of technological innovation in a regulated industry. It also tends to force some users to subsidize others. For instance, smaller towns and cities get more airline and rail service than in economically justified, at the expense of all other users--especially the larger cities. Similarly, suburban and rural homeowners normally receive electricity, gas, water, sewage, and telephone service below actual cost--whereas central-city users pay extra--due to "uniform pricing" policies imposed by regulatory agencies. On the other hand, regulation forces all users of automobiles to pay for extra emissions control equipment (and fuel) due to the air pollution problems of certain geographical regions and congested central cities.

Taken as a whole, economic regulation is a subtle--almost invisible--way of redistributing income. But "winners" from one type of regulation may be "losers" in another: the redistribution effects of all regulatory activities are probably fairly neutral for most of the population.

Losses to the whole economy due to inefficiencies created by regulation would be a more serious matter, but the magnitude of such losses are not known except in very narrow cases. The rapid growth of economic regulation over the past half-century suggests, however, that more regulation is a strong possibility for the future. Price controls, wage controls, and rent controls are the most likely, and the allocational inefficiencies and economic "drag" that would be introduced thereby would indeed be far more severe than anything we have so far experienced in the U.S. As soon as government steps in to hold down prices in one sector (such as housing) by regulation alone, profits fall and that sector becomes unattractive to private investors. Thus, the government also immediately becomes the only possible source of capital funds to increase the supply of housing; the supply of publicly financed units lags behind demand; and allocation of the limited supply becomes a problem. Since market price is no longer a factor, other criteria must be used--such as political favoritism, under-the-table payments, or waiting lists.

With regard to intercity transportation specifically, the adverse impact of railway unions on productivity has already been noted. All intercity common carriers are highly unionized and subject to the possibility of

crippling strikes and work rules. In contrast, the impact of possible intervention by the courts on intercity transport has been relatively mild so far. The effect of regulation by the ICC and CAB has, however, been extremely important. Competition between modes or routes has been minimized, and the watchword has been "service." All regulated modes have, consequently, been forced to provide services to many locations and sectors whose real needs would not justify it on an economic basis. The cumulative impact of regulation has been to raise costs of transportation for all users--especially in the large cities--while substantially redistributing income in favor of smaller towns and rural areas. If the regulatory agencies were significantly dismantled, this bias toward decentralization would be ended.

Changing Patterns of Demand

It is often remarked that the U.S. economy is shifting from a manufacturing base to a "service" base, with emphasis on the public sector. While this is crudely true, the real picture is considerably more complex. A division of total national income by industry group since 1929, is displayed in Figure V-6. The relative importance of the sectors was obviously severely distorted by the depression--when manufacturing activity dropped much more sharply than other sectors of the economy--and by World War II. If the 15 years between 1930 and 1945 are omitted, long-term trends are much clearer.

Three trends are particularly marked: (1) extractive activity (farming and mining) declined sharply as a percentage of the national economy; (2) "communications, finance, insurance, business services and general government" rose very sharply; and (3) transportation, utilities, retail and wholesale trade, government enterprises, real estate, and households also declined significantly. The latter is perhaps surprising, at first sight, but one of the major factors accounting for it is the decline in energy costs. There has also been a shift after World War II away from *purchased* transportation to *privately owned* transportation (i.e., automobiles) which increases the output of the auto industry at the expense of railroads, for instance. Similarly, the sharp growth of individual home ownership (as opposed to rental housing) has greatly benefited the construction industry. Finally, the general increase in personal mobility--due to widespread car ownership--has reduced the need for neighborhood shops and the relative importance of retail trade. Similarly, the spread of labor-saving appliances has decreased the importance of household services: washing machines have affected commercial laundries, home TV has replaced both live and motion picture theaters, etc.

From now until the year 2000, however, some of these historical trends may again reverse themselves. First, the extractive industries will certainly increase in relative importance due to higher energy and food prices. The U.S. will become increasingly important as a food exporter to the rest of the world, and accelerated coal and oil shale development

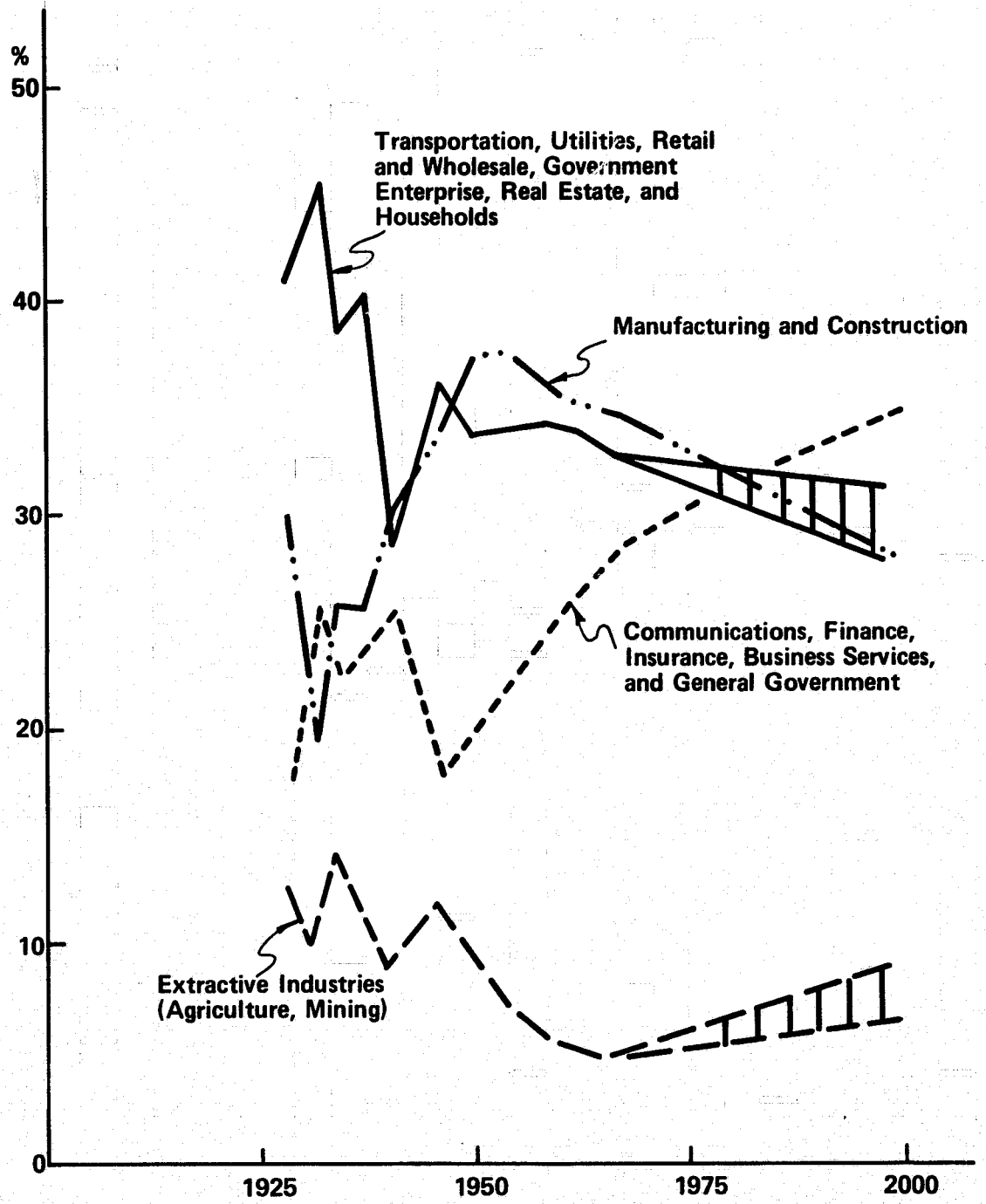


Figure V-6. COMPONENTS OF NATIONAL INCOME

will take up the slack from declining oil and gas output. Second, the shift from purchased services (in housing and transportation) to services provided by manufactured products is largely complete. New growth in housing, cars, and appliances will be less and less important. Most sales will be replacements. The only real consumer growth areas are health, entertainment, and recreation. In all three areas, there are still large potential markets for manufactured products from home videotapes to campers and boats, but network services (such as the telephone system and large time-shared computer systems) will be an integral part of these markets. Hence, the relative importance of manufacturing and construction is likely to decline significantly as compared to the communications and tertiary services sectors.

Further, it is important to bear in mind that the substitution of services provided by privately owned homes, vehicles, appliances, etc., for purchased services is partly attributable to tax advantages. The tax benefits of private home ownership are well-known. But some of these benefits--especially the deduction for interest costs--are also applicable to other areas. In general, income tax laws currently favor private purchase of durable (i.e., capital) goods rather than rental from an operator. Of course, these laws are subject to possible change.

The slowdown in population growth, mentioned elsewhere, will also have a major impact. The U.S. will become a much "older" society by the year 2000 as a result of population growth slowdown. This will almost certainly have major sociological impacts, such as increased emphasis on health care vis-à-vis education, reduced levels of crime and drug bause, more multiple dwellings, revival of the central city as a residential location vis-à-vis low density suburbs, etc.

An obvious and important trend of the last several decades, which is likely to continue, is the growth of public sector spending at the expense of private consumption. During the 1950s and early 1960s much of this increase was accounted for by growth in local government services due to rapid suburban development, especially schools. Rapid increases in social service spending, especially social security, medicare, "medicaid," and various types of welfare have been the major factor in the past decade. These latter categories can be expected to continue to grow rapidly as the U.S. population grows older.

With regard to intercity transportation, the increasing importance of leisure time and recreational activities is obviously an important factor. Many intercity auto trips are essentially recreational. Indeed, a growing segment of the population--at both ends of the age spectrum--is more or less "footloose," with no fixed permanent place of residence. These people have organized their lives for maximum mobility, based on private vehicles (mobile homes, campers, etc.) which double as part-time residences. This trend will doubtless increase if personal incomes continue to rise--unless fuel becomes unreasonably expensive. People who are committed to specific locations, of course, may also utilize recreational vehicles. But, having limited time for

personal travel, they are more likely to favor speed so as to minimize time *en route* to a destination. This is the basis for the private (non-business) use of air transportation and it, too, will increase as long as incomes rise.

The Problem of Resource Availability

The recent controversy on adequacy of available resources and possible "limits to growth" is merely the most recent episode in a continuing debate. The neo-Malthusian view is, in brief: We live on a finite earth on which there exists a "limited stockpile" of nonrenewable natural resources. While only a fraction of the potentially accessible resources have been uncovered by geological exploration, eventually all deposits of minerals or fossil fuels will be found and "used up." An exponential rate of population and economic growth (such as we are currently experiencing) greatly accelerates this approaching time of scarcity, as suggested by Table V-3 which follows. The reaction of many conventionally schooled resource economists to this proposition is essentially one of *deja vu*. They see the questions being raised today by the Club of Rome, and various environmentalists--as well as a number of mineral resource producers--as being repetitions of naive arguments that should long ago have been laid to rest.

There are two basic objections to the neo-Malthusian position:

1. Technological and economic progress will enable us to recover minerals from ores of ever-decreasing quality and more remote locations--not excluding the ocean floors, or even the moon--resulting in a steady growth of "available reserves" as defined by the usual economic criteria. In brief, as one source of supply is exhausted a substitute usually becomes available. This has been occurring, at least in recent decades, as shown in Table V-4. Superficially, at least, Table V-4 seems to contradict Table V-3.

2. To the extent that supply is inelastic in the short run, and temporary imbalances occur between supply and demand, the problem will simply be resolved on the demand side by a price adjustment. In particular, if "shortages" occur, the resulting price increases will result in automatic decreases in demand for the material, and substitution of alternatives.

In the last 20 years, the U.S. has also become far more dependent on imported metal ores (except copper and lead), and this general trend will continue, as shown in Table V-5. By the end of the century, the U.S. is expected to import most of its mineral requirements except for phosphorus and sulfur, according to the U.S. Department of Interior. This dependence on foreign sources could lead to increased U.S. vulnerability to cartelization and price manipulation in the interests of the exporting countries.

Table V-3

LIMITED STOCKPILE VIEWPOINT:
CALCULATED TIME TO EXHAUSTION, BASED ON "PRESENT KNOWN RESERVES"

Resource	Number of Years To Exhaustion, at Current Level of Consumption (years)	Usage Rate of Growth (%/year) 1960-68)	Number of Years to Exhaustion, Allowing Exponential Growth at Current Rates (years)
Aluminum (Bauxite)	175	8.1%	34
Chromium	560	3.2	92
Coal	900	0.7	595
Cobalt	155	4.6	45
Copper	40	3.3	25
Gold	17	2.5	14
Iron	400	3.8	73
Lead	15	2.9	12
Manganese	180	4.5	49
Mercury	13	-0.3	13
Molybdenum	100	8.1	27
Natural Gas	35	11.2	14
Nickel	140	8.7	30
Petroleum	70	10.3	20
Platinum	20	8.5	12
Silver	20	1.8	17
Tin	25	4.2	17
Tungsten	40	0.5	36
Zinc	18	6.2	16

Source: D. Meadows, et al., *Limits to Growth*, Potomac Associates.

Table V-4

"EXPANDING BUCKET" VIEWPOINT
INCREASES IN KNOWN RESERVES, WORLD

Resource	1956	1960	1970
Chromium, 10^6 short tons	200	--	775
Copper, 10^6 short tons	100	170	307.9
Lead, 10^6 short tons	40.5	48.8	95
Mercury, 10^6 flasks	0.6	2.0	3.2
Platinum, 10^6 Troy ounces	25	25	424
Tin, 10^6 long tons[a]	5	5	6.5
Zinc, 10^6 short tons[a]	70+	67	90

a. Free World only.

Source: U.S. Bureau of Mines, *Mineral Facts and Problems.*

Another perspective on what has happened during the last century may be helpful in evaluating this threat. Figure V-7 shows the *relative* economic effort (fraction of GNP) needed to obtain nonrenewable raw materials for the U.S. economy since 1900.

These trends clearly indicate that, despite rapidly rising per capita consumption, measured in physical quantities (pounds), and notwithstanding that the quality of ore actually being mined at the time has decreased significantly in the last 20 years alone,* *the fraction of our total national income needed to acquire nonrenewable resources of all types has nevertheless showed a steady--indeed, dramatic--decline.*

*From 1950 to 1970, U.S. ore grades mined have declined 12% for aluminum, 50% for antimony, 33% for copper, 3-1/2% for fluorine, 47% for mercury, 12% for molybdenum, 63% for thorium, 35% for tungsten, 33% for vanadium, and 29% for zinc. The discovery of new deposits of lead and silver have resulted in ore grade increases for these two of 80% and 8% respectively.

Table V-5

U.S. DEPENDENCE ON IMPORTS OF PRINCIPAL INDUSTRIAL RAW MATERIALS WITH PROJECTIONS TO 2000

Raw Material	Percent Imported			
	1950	1970	1985	2000
Aluminum	64%	85%	96%	98%
Chromium	n.a.	100	100	100
Copper	31	0	34	56
Iron	8	30	55	67
Lead	39	31	62	67
Manganese	88	95	100	100
Nickel	94	90	88	89
Phosphorus	8	0	0	2
Potassium	14	42	47	61
Sulfur	2	0	28	52[a]
Tin	77	n.a.	100	100
Tungsten	n.a.	50	87	97
Zinc	38	59	72	84

a. Not taking into account the possible availability of secondary sulfur from pollution abatement efforts.

Source: U.S. Department of the Interior.

A geochemical perspective on the resource picture is interesting in this connection. As of the late 19th Century, all metals in large-scale use except iron--namely, lead, zinc, tin, mercury, copper, and silver--had the common characteristic that they tend to occur in rather concentrated deposits, mainly as sulfides. The pure metal can be recovered by a simple roasting process in the presence of air (the sulfur being separated and discharged to the atmosphere as sulfur dioxide). Areas around such smelters tend to be among the most persistent reminders of

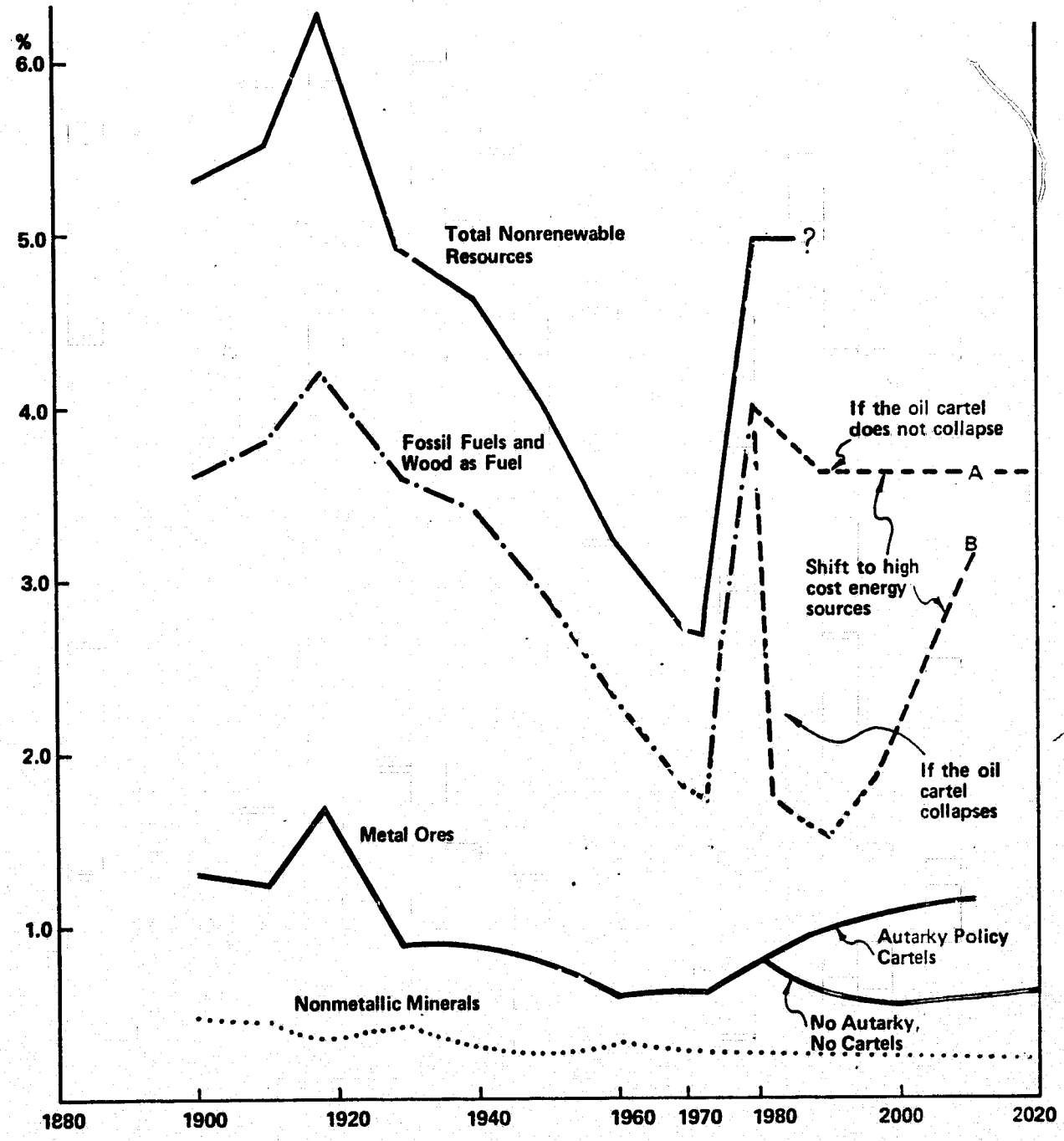


Figure V-7. PERCENT OF GDP REQUIRED TO EXTRACT NONRETURNABLE RAW MATERIALS, EXCLUDING IMPORTS

man's carelessness with the natural environment. In retrospect, however, *it is clear that these metals were extensively utilized largely because they were easy to locate and easy to extract from natural sources, and not because of "uniquely" valuable properties.*

The 20th Century has seen two marked technological shifts. One is the rapidly increasing use of light elements, starting with aluminum. More recently, magnesium, titanium and beryllium, boron and silicon have found significant applications. From a resource availability standpoint, this is noteworthy for two reasons: (1) the elements in question (plus iron) are all far more abundant than the heavier metals; and (2) they are much harder to reduce to pure form being found as oxides, silicates, aluminates, and so forth. Practical metallurgical processes almost exclusively rely on electrolysis which is inherently much less polluting than sulfide roasting (but obviously requires more energy).

The second major technological development of the 20th Century is the development of carbon-based polymers. First came polymers derived from cellulose (notably rayon). In the last three decades, these have been followed by polyamides (e.g., nylon), polyesters (e.g., dacron), acrylics, and vinyls (e.g., polyethylene, polypropylene, polyvinyl chloride, polystyrene, plexiglass, and synthetic rubber). Synthetic fibers already account for 36% of total worldwide fiber consumption (up from 3% in 1930). Consumption of plastics already exceeds consumption of steel by volume; though only one-seventh the density of steel, relative growth rates are such that output of plastics is expected to exceed steel output even on a weight basis within a few years.

Synthetic fibers and plastics are currently derived mainly from natural (fossil) hydrocarbons. Use of fossil hydrocarbons for these materials is nevertheless quite small compared to their use as fuel. If there is a hydrocarbon scarcity problem, it is only due to the demand for the latter purpose. (Incidentally, conversion of hydrocarbons to polymeric form still leaves most of the energy content intact. Thus, waste plastics can be used for fuel *after* their value as materials per se is exhausted.)

At least ten elements currently derived from air, sea water, sand, limestone, or gypsum have an effectively infinite resource base at constant costs. If costs are allowed to rise modestly--assuming new technology--above present levels, to permit exploitation of somewhat lower grade (but more widely available) resource basis, a further 12 elements also join the list: iron, aluminum, magnesium, sodium, potassium, lithium, calcium, carbon, silicon, and boron are included. It would appear that we are experiencing a slow but pronounced trend toward the use of lighter materials, which happen to be much less scarce than the important metals of the late 19th and early 20th Centuries.

For the reasons noted above (and others), a severe shortage in the supply of metallic ores seems unlikely to occur. The range of possible

defense mechanisms, from stockpiling, to recycling, to technological substitution is too formidable.*

Unfortunately, as yet there has been no major substitution of nuclear, solar, or other nonfossil sources of energy, and the Project Independence report makes it clear that the U.S. will necessarily continue to be heavily dependent on fossil fuels for most of the next 30 years. The cartelization of the world's major oil exporters has led to sharply higher prices for all fossil fuels and a corresponding increase in the share of GDP needed to acquire energy. It has also resulted in intensified worldwide exploration for new sources of petroleum and gas, and intensified development of technologies for coal liquefaction and/or gasification. These responses will eventually put a ceiling on energy costs. Whether costs drop dramatically after 1980 depends on whether the OPEC cartel is able to continue to control prices in the more competitive excess-supply situation likely to prevail then. But such a decline could hardly be expected to last for more than a few years.

It is worth pointing out that even if all fossil fuel costs double, *on the average*, the U.S. would be in roughly the same situation as regards economic effort to acquire energy resources as it was in 1940 when the country was entirely self-sufficient in this respect. Thus, the national impact would clearly be tolerable, though hardly "painless."

The impact on certain specific industries--or specific intercity transportation modes--can be much more severe, of course. Both aviation and private automobiles have "grown up" in an era of declining energy costs and both will be adversely affected vis-à-vis their competitors (rail, bus) in a different environment. On the other hand, energy costs are only one of many competitive factors; labor and capital costs are others, as noted already.

Conclusion

Several key parameters have been isolated and identified as shaping the U.S. economic picture over the next 30 years: a continuing capital shortfall, the uncertain future of productivity, unemployment and inflation (and the organized labor monopoly), institutional rigidities, the economic shift to service sectors, and resource availability (particularly energy). The impact of these parameters on ICT are, and will continue to be, manifold in areas such as the following: availability of investment capital, possibilities for technological innovation, demand for services, costs of services (including energy costs), and delivery and distribution of services among localities.

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*R. Ayres, A. Shapanka, D. Robertson, "Critical Materials: A Problem Assessment," IRT-348-R, May 1974.

VI. FINANCIAL ISSUES IMPACTING INTERCITY TRANSPORTATION

by

J. P. Price and R. W. Luce
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ABSTRACT

Investment decision-making criteria used by financial managers in the transportation industry depend upon who owns the enterprise. Finance, investment, and production objectives of a private institution often differ from those of public ones. Because transportation provides vital public service, private sector decision-making processes may not meet public policy goals. Though the federal government uses its own surrogate for a return on investment (ROI) decision-making mechanism, it does not attempt to maximize bookkeeping profits, since it must include in its evaluation of "returns" the improved welfare of the general public, quality and quantity of service, and other nonmonetary contributions to social "profits."

Recent studies project a serious capital shortfall over the next 5 to 25 years, slowing the nation's real economic growth, reducing the rate of improvement in labor productivity, and hurting the capital-intensive industries. This situation has contributed to a doubling of the corporate debt-to-total-asset ratio over the past two decades, and to the use of short-term debt--with rising interest rates--in lieu of long-term debt. Greater portions of internally generated and long-term corporate funds are, consequently, diverted to satisfy short-term debt, creating an additional drag on the rates of capital formation and investment.

The accelerating pace of change in the economic institutions affecting businesses (e.g., double-digit inflation, recession, and the ever-changing phases and freeze of price controls) has made the future increasingly uncertain. Investors require higher ROIs to compensate for the added risk.

The projected capital shortfall will heighten pressures for a federal, direct capital allocation program, which generates several questions: (1) are the direct economic controls of the government's economic managers sophisticated enough to replace the allocation function of the market with direct controls? (2) will political pressures distort the economic planning process? (3) who will receive and who will supply the funds? and (4) how will capital rationing affect the investable funds supply?

Institutionalization of capital markets portends a clash between large financial institutions and the government over transportation policy. Large financial institutions, because of their huge supplies of investable funds--often held in trust for corporate pension and profit-sharing plans and therefore subject to legal and financial investment constraints--prefer to invest in large-size companies. The resulting decline in speculative investments in smaller, often more innovative companies may significantly undermine the private sector.

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Federal tax policies strongly influence the levels of capital internally generated by a firm. Proposed tax reforms--for example, a reduced corporate tax rate, acceleration of the capital asset depreciation rate, or the full or partial removal of the double taxation of corporate dividends--would improve the attractiveness of equity financing relative to debt financing, especially for major sectors of the transportation industry.

Transportation is, both operationally and financially, a highly leveraged business. A high portion of total operating costs are fixed. A large portion of total capitalization is provided by debt instruments; interest and rents must be satisfied before net income accrues. Small changes in total revenues (changing patronage or load factors) therefore, significantly affect net income.

Intercity transportation (ICT) is particularly vulnerable to a capital shortfall. Its future success heavily depends on investor confidence. Long-term investments in transport properties are unattractive because the creditor has no immediate power of repossession. Low price/earning ratios, prohibitively high costs of equity financing, and rising energy costs (a major operating expense), all have an impact on the ability of highly leveraged carriers to attract investment capital. (The amount of compensation received by creditors of the Northeastern rail bankrupts will set an important precedent.)

A key issue is whether the federal government's role should be one of regulation or ownership. Government ownership has been appropriate for those parts of transport process which do not attract private investments, e.g., highway, waterway, airport, and bridge infrastructures (and probably railway rights-of-way and structures). Direct (e.g., local service air carriers) and indirect (e.g., the structure of highway user fees) subsidies have been used to avoid direct government ownership. Capital subsidies and grants have been provided to rapid transit systems, railroads, and AMTRAK for equipment modernization. Other techniques to attract investable funds include debt guarantees, subsidization of debt service, special tax credits, interest tax exemptions, and interest expense sharing. Intracorporate cross-subsidies are also a method to induce a desirable service.

An accounting system, capable of functioning as a management information system, is needed to accurately reflect the actual service life of transportation assets. Intelligent investment decisions by transportation managers and investors depend upon an understanding of both the enterprises' performance and infrastructure depreciation costs.

Matching fund programs have been used to delegate many public sector investment, planning, and implementation decisions to state, regional, and local levels. Outright grants often, however, generate biases in favor of capital-intensive solutions and in the cost/benefit ratios of projects; they also reduce nonhardware innovations in institutional practices and marketing.

VI. FINANCIAL ISSUES IMPACTING INTERCITY TRANSPORTATION

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VI. FINANCIAL ISSUES IMPACTING INTERCITY TRANSPORTATION

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The purpose of this paper is to identify and assess the significant financial factors, frequently interrelated and highly complex, that are likely to influence the direction of development of intercity transportation. The paper considers macroeconomic issues affecting the national financial community and specifically applies these issues to the transportation sector.

National Economic and Financial Factors

Investment Criteria. The investment decision-making criteria used by financial managers in the transportation industry, identical with those of their counterparts in other industries, are fundamentally shaped by the ownership of the enterprise; therefore, finances, investment, and production objectives of a privately owned, profit-maximizing firm will often differ from those of the publicly owned institution.

In the private sector:

> "The corporate firm confronts, in fact, a trilogy of optimization decision problems. These relate to the mutually dependent areas of production, investment, and finance. In short, the production problem is concerned with defining the optimum level and mix of product outputs and the optimum combination of input factors of production. The investment problem is concerned with the optimum combination of real and monetary assets in which the firm should invest in order to establish and maintain the productive process necessary to produce the optimum output with the optimum combination of factor inputs. The finance problem is concerned with the optimum combination of sources of money capital with which to finance the optimum asset investments."*

When evaluating a prospective asset acquisition, the decision-makers will measure the rate of return on investment (ROI), a calculation performed in several similar ways embodying varying levels of sophistication all of which are designed to measure the flow of revenue generated by a new asset. The expenses required to operate the asset (if any) are deducted against the revenue. The net amount, or "cash flow,"

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*Vickers, Douglas, "The Cost of Capital and the Structure of the Firm," *The Journal of Finance*, 1971.

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is estimated for each year of the asset's service life and is then discounted to present value. The financing constraint closely influences investment decisions because the discount rates which are applied in the net present value calculations should reflect the marginal cost of capital for the firm. When the net present value of the asset exceeds its purchase price, the investment is desirable.

The constraint upon total investment is that the cost of capital rises as the demand for funds increases. Optimization of investment and financing requires the balancing of the trade-offs between the declining returns on the array of potential investments with the increasing costs.

This decision-making process may not be socially acceptable in the transport context. Transportation is a service which provides substantial external benefits to the public as a whole, yet suppliers of the services receive compensation from direct users only. The quantity and quality of service provided by private ownership and operation is usually acceptable; however, when the natural monopoly* characteristics of an industry are especially pronounced, this may not be the case. In these instances, services vital to the public interest will only be provided when the government assumes an active role in ensuring that the scale of the industry's infrastructure will reflect the substantial value of the benefits accruing to the general public--the external benefits.

Because of these conditions, government ownership, operation, and regulation have emerged as responses to the substantial public interest in transport services. When the government takes an ownership role in transport, it too, will implicitly follow an ROI decision mechanism. The government does not, however, attempt to maximize "profits" as defined by private enterprise because the appropriate level of "returns" on the public investment must account for the improvement in the general welfare of the overall public--not just that of the suppliers and direct users of the service. As a result, qualities and quantities of services become the predominant focus of the public enterprise manager. Service levels determine whether the payoff to the investor--the public--is "profitable"; if the current level of service of a public transport system is not meeting the public needs, then its funding will be changed, to wit, the massive federal funding of AMTRAK's investment program in order to boost dramatically the quality and quantity of service of that public enterprise.

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*Natural monopoly is an industry in which one firm only is the appropriate producer of all output because it reaps all the benefits of economies of scale. Thus, this industry must have a downward sloping cost curve.

Adequacy of National Level of Capital Formation. Improvements in labor productivity necessary to maintain real economic growth require substantial new capital investment. Probably the most important financial issue facing the economy today and determining its future direction is whether the level of capital investment over the next 25 to 50 years will be adequate to maintain the nation's historic economic growth rate.

Most of the recent studies of investment demand and supply in the economy have projected serious shortfalls over the next 5 to 25 years. One of the best known of these studies, published by the New York Stock Exchange in September 1974, has projected that the supply of investable funds will fall approximately $650 billion short of investment needs over the next ten years. This represents a shortfall of almost 15% of overall projected investment needs of $4.5 trillion, that would have major negative implications for the nation's economic future; it would slow real economic growth, reduce the rate of improvement in labor productivity, and put capital-intensive industries at a severe disadvantage.

A significant factor in the projected substantial shortfall in investment funds over the next decade is the sharp decline in the portion of capital outlays financed through internally generated funds (retained earnings and depreciation charges). In 1967, over 65% of private capital outlays were financed by internally generated funds. By 1974, that percentage had dropped to 38.5%. The two major reasons for the decline are the rapid rise in capital outlays, due partially to increases in the cost of capital goods, and declining levels of profits (measured in real dollars) in most sectors of the economy. Whether the portion of capital funds internally generated will improve in the future is a major issue affecting the overall level of capital formation itself.

The resulting need on the part of corporations to finance externally a larger portion of their capital needs has put a substantial strain on their financial condition. Partly because of a corporation's frequently easier access to debt capital markets and because of the structural incentives to finance with debt, a large portion of additional financing needs have been met by the issuance of debt instruments. (Over the last decade, only 18.7% of new financing was common stock with an additional 8.2% being met by fixed income securities convertible into common stock.) Because of heavy reliance on debt, in two decades the debt-to-total-asset ratio of corporations has more than doubled, from 21% in 1955 to 47% in 1974. At the same time, interest charge coverage has fallen from 27 times in 1952 to just 6 times in 1974. A substantial portion of corporations have had such debt-heavy balance sheets that significant financial risk extends past equity holders to creditors.

During the poor capital market conditions of the past few years, corporations have been not only forced to substitute debt for equity, but also frequently to use short-term debt in lieu of long-term debt. The

risks associated with relying heavily on short-term loans to finance current assets were brought vividly into perspective when short-term interest rates rose to previously unthought of levels during 1973 to 1974. It is now likely that corporations will use a portion of internally generated funds and long-term funds to pay down short-term debt.

This use of investment funds would drain a meaningful portion away from capital investment, creating another drag on the level of capital formation. Since the banking system was also strained severely in 1973 to 1974, the banks will not be immediately anxious to relend a meaningful portion of these loan repayments. This action will also lead to the siphoning off of funds for new capital investment.

Impact of Government Economic Policies. The demand curve for investable funds is highly dependent on corporations' and other investing enterprises' views of the future "profitability" of the numerous proposed investment projects.*

Over the past few decades, the accelerating pace of change in the economic institutions affecting business has made the projection of future economic prospects increasingly uncertain. As a result, investments appear riskier, and investors require a higher rate of return to compensate for the added risk. An important issue affecting the level of capital formation is whether government policy has helped to allay this problem by being long-term oriented and consistent in its policy, or whether it has exacerbated the problems by frequently altering short-term policies. An example of the latter policy problem has been the nation's experience with price controls; the frequently changing phases and freezes hampered businesses' abilities to forecast, thereby undermining confidence in making major investments. Business concern about the possible reimposition of price controls may be one factor in the downward rigidity in the prices of many goods during the past year despite massive inventory overhangs.

The nation's economic experience during the first half of the 1970s, with double-digit inflation overlapping the nation's worst recession since the 1930s, has created a debate as to what the government's economic stabilization philosophy should be. Should it continue to attempt to offset cyclical fluctuations in the private sector of the economy or should it accept the more modest goal of merely dampening the economic cycle by pursuing constant monetary and fiscal policies?

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*"Profitability" is used here advisedly since the attractiveness of a project from the investor's viewpoint is likely to be based on more factors than simply profits.

Allocation of the Supply of Capital. If the projected sizable shortfall in investable funds develops, pressure will grow for some form of federally controlled system of allocating capital, and if a direct capital rationing program is chosen, the government's long-term economic planning role will have been substantially expanded.

The liberal argument in favor of capital allocation is that investable funds are not in short supply, but instead are being used inefficiently on such things as an overabundance of shopping centers and vacation homes. The conservation argument is that the free flow of money is at the very foundation of the free enterprise system and cannot be altered without severely damaging the whole system.

Put in less ideological terms, the issue of direct capital allocation raises several questions. First, are the tools of economic management sophisticated enough to replace the allocation function of the marketplace with direct controls? Second, is the nation's political decision-making process more sensitive to long-term economic forces or short-term political pressures? Third, how would the advent of capital rationing affect the supply of investable funds? In other words, would potential investor confidence in the economic future be negatively affected to the extent that the total level of available investable funds would be reduced?

One issue not mentioned in the above discussion is the balance between consumption-oriented and investment-oriented expenditures in the government budget. While historically the overall impact of the federal budget has been consumption inducing, a greater portion of government expenditures could be investment-inducing in the future. Such a change would give the government a greater role in direct capital allocation since capital projects within the budget would be funded using the government's ease of access to the capital markets. This trend might be increasingly used by the transportation sector to finance its investments.

The trend toward institutionalization of capital markets also affects the allocation of investable funds. Currently, over 60% of the volume of stocks traded on the New York Stock Exchange is accounted for by financial institutions; households continue to be net sellers of common stock at a rate of over $6 billion annually. Increased institutionalization concentrates the influence over investment decisions by a small group of large financial institutions; correspondingly, the potential for institutional clashes with the government over transportation policy will increase.

There are several implications of this trend for the allocation of investable funds. Because of the huge number of dollars controlled by a financial institution, the size of an investment in a particular security is frequently constrained by market factors, as well as by regulations of the SEC and other agencies. An institution does not

want to own such a large percentage of a security that it would substantially upset market equilibrium by attempts to sell its block. As a result, institutions prefer to invest in large-size companies with broad-based issues on the market.

Also, a substantial portion of funds invested by financial institutions is held under trust or fiduciary arrangements, primarily in corporate pension and profit-sharing trusts and subject to a growing body of legal restrictions as to how these monies can be invested. Most states have a list of acceptable securities, again populated primarily by large, well-established companies. The recent pension reform act tightens the "prudent man" restrictions. The trade-off between the safety of an investment and its potential return has been skewed toward a greater emphasis on safety. This combination of factors tends to increase the competitive disadvantage of smaller, more speculative investments and may significantly dampen the innovation and dynamism of the private sector; smaller, more speculative companies often are the source of innovative ideas, and their added competition spurs innovation by more firmly established corporations.

Government Tax Policies. Government business taxation policies play an influential role in determining the amount of capital corporations can generate internally. Currently, a tax reform to enhance the level of capital formation is in the initial stages of consideration by Congress. The outcome of these considerations is likely to have an important impact on the level of capital formation over the next several decades. A reduction in the corporate tax rate would increase after-tax profitability, not only improving the anticipated return from investment opportunities but also improving the level of internally generated investable funds.

Changes in taxation would improve the attractiveness of equity financing relative to debt financing. At the present time, corporate dividends are taxed twice, first as corporate profit and second as income to shareholders. Since the cost of other forms of financing, debt, or leasing for example, are expenses in determining taxable income, an artificial disincentive to the use of equity capital exists. Among the taxation changes being contemplated is full or partial removal of this double taxation, as in the tax revision recently suggested by Treasury Secretary Simon. These changes might reopen equity financing for major sectors of the transportation industry.

The modification of other business taxes would also affect the level of capital formation and influence the relative attractiveness of different types of investments. For example, the acceleration of the tax rate of depreciation for capital assets would improve the anticipated cash flow stream and the ability of firms to generate capital internally. A lowering of capital gains tax rates would increase the relative attractiveness of equities.

The exemption from federal income taxation of a fixed amount of income received by individuals from savings accounts has also been considered. It is not clear whether such a change would only divert a larger amount of existing savings to the banking system or whether it would actually stimulate additional savings and, therefore, the supply of investable funds.

In each of these proposed tax changes, there are two separate issues: What will be the effect of the changes on the level of capital formation? What will be their effect on the allocation of investable funds between competitive uses?

Financing of Transportation

The preceding portion of this paper addressed financial issues affecting the entire economic community. Given the transportation sector's central place in the economy, these issues all have important implications to transportation. The remainder of this paper will focus upon those financial issues more specific to transportation. This section identifies reasons for public involvement.

Operating Leverage. Transportation is a highly leveraged business because, relative to most industries, a high portion of total costs are fixed costs--unavoidable expenses of operation which do not vary with output. Depreciation on equipment and infrastructure are significant fixed costs. Other operating costs which do not vary significantly with patronage are sales costs and some costs of maintenance, rentals, overhead, etc. Operating margins and profits are extremely volatile; a small percentage change in total revenues or total costs will have a very significant effect on net income.

Leverage causes volatile profits because slight changes in patronage will have dramatic effects on profits. Once the transport vehicle is committed to operate, one additional passenger on a flight, in a bus, or on a train adds revenues which are almost pure profits, since operating expenses increase only minimally. Operating leverage is particularly pronounced in the case of airlines and passenger railroads whose management focuses heavily--sometimes myopically--on load factors, which measure the percentage of capacity producing revenues. A slight change in load factors means millions of dollars in revenues for most airlines; a year well in the black turns to deep red with a drop in load factor from say, 54% to 48%.

One of the overriding economic issues has been, then, the search for techniques to assuage the risks inherent in the leveraged nature of the transport business.

Financial Leverage. Transportation companies (especially airlines) are also characterized by substantial financial leverage, which is similar to operating leverage in that a small percentage change in revenue will have marked effects on a net income. Financial leverage is wholly attributable to having a large proportion of total capitalization in the form of debt instruments whose interest and rental payments must be satisfied before net income accrues to pay the stockholders.

Debt financing is attractive to most transportation companies because it is the logical means of financing the fixed infrastructure and equipment, because the cost is low relative to equity, and because the debt instrument--lease, bonds, convertibles, mortgages, conditional sales contracts, equipment trust certificates--can be matched to the service life and cash flows of the investment. Long-term bonds and mortgages are of limited use since they are needed to finance long-lived infrastructure such as rights-of-way. A few railroads still acquire fixed infrastructure, but on the whole, most are reluctant to tie up funds for 50 years. The airlines, bus companies, and private autos have these facilities financed by the government so they do not need the highly secured long-term securities. One of the key issues which will be discussed subsequently is why the government has interceded to provide the financing for the fixed infrastructure.

Most transportation enterprises focus their financing on investments with service lives less than 20 years. The obvious investment is equipment: aircraft, buses, cars, rolling stock, cargo-handling equipment. Some very specialized financial instruments--equipment trust certificates, conditional sales contracts and leases--have been developed in order to maximize the security held by the supplier of funds. These devices allow title to remain with the lessor or a trustee. In the event of default, the collateral (equipment) can be repossessed and sold to other transportation companies in need of this equipment. The security of these financial instruments has enabled weak firms, incapable of any other form of financing, to acquire new equipment. In addition, tax benefits accruing to the creditors are shared with the debtor.

Another form of debt financing used widely in this industry are leases of buildings and other facilities, which shield the balance sheets of the transportation companies from the massive debt-like obligations implicit in intrastructure such as the airport-airways system. Airlines do not report obligations to rent airport terminal facilities as liabilities on their balance sheets; however, these commitments are a noticeable proportion of total fixed charges. Even though the users of transportation terminals are conventionally regarded as "tenants" of the facility, the whole reason for transportation terminals is to serve as an interface between several modes. Terminals are built at the behest of the transport companies, and they are paid out of charges assessed against the users. In effect, the government has gone into the business of owning and operating terminals, and the carriers pay

for them via user charges--space rentals, user fees (e.g., landing fees), ancillary rentals, taxes, etc.--which are a technique to finance highly capital-intensive sectors of the companies' infrastructure.

Investor Confidence in Intercity Transportation Financing. Traditionally, the private sector has played a major financial role in the capitalization of the United States intercity transportation networks, and it is likely that any shortfall in the level of investable funds will hit this financing particularly hard. Generally, intercity transportation is more capital intensive than the rest of the economy. The heavy capital outlay needed to increase capacity to meet demand growth or to incorporate technological advances in order to reduce expenses and increase profitability will be particularly vulnerable to a capital shortfall.

An important issue in this industry is the security of mortgages and long-term debt instruments which are meaningful to creditors when effective liens can be enforced against the enterprise's properties. These liens often cannot be enforced without a determination that the public is not harmed, because these properties are devoted to providing services which are vital to the public interest. Thus, long-term investments in transport properties are not attractive to holders of debt because the lien does not provide the lender with the power to repossess the properties quickly.

The future success of intercity transportation in attracting capital heavily depends upon the future level of investor confidence. To a great extent the outcome of the current Northeast rail situation will have a fundamental influence on investor confidence in transportation debt instruments. Even though railroad bankruptcies are not unusual, the experience of the Penn Central and other bankrupt Northeast railroads is quite unique. Previously, bankruptcies were traceable to an inability to meet high levels of fixed charges; railroads still achieved operating profits and could be successfully reorganized by restructuring their capital structure, in order to reduce the debt burden hanging over the enterprise. Unlike past situations, the Penn Central has not earned positive cash flows; a reorganization on an income basis is, therefore, impossible. If this situation existed in a manufacturing firm, the trustees would take action to liquidate the firm by selling its assets as quickly as possible to minimize the erosion of the company's assets. In the case of the Penn Central, its social value as part of the economic infrastructure is so great that cessation of rail service would be an intolerable hardship upon the public interest; as a result, a collision between creditors' interest and the public interest existed and continues to exist.

In early 1974, the Regional Rail Reorganization Act of 1973 (RRR Act) was enacted to avert this collision. The RRR Act provides for federal government financing to rehabilitate the infrastructure and equipment

of the bankrupts. The properties are to be "transferred" to a new company, the Consolidated Rail Corporation (ConRail).

Compensation received by the creditors of the bankrupts for the transferring of ConRail's properties will have a crucial influence on future railroad financing and other transportation financing. If the creditors are dissatisfied, investor confidence in all transportation industries may be undermined.

Equity is another means of raising capital where success is dependent upon investor confidence. It is normally the highest cost form of financing and is only feasible when a transportation company has a high price/earnings ratio. The price/earnings ration accorded a stock is dependent upon the risk investors perceive and their confidence in future earnings prospects.

Because of the risk concomitant with the leveraged condition of many transportation companies, the price/earnings ratios are generally low, and the cost of equity financing is prohibitively high. Investors also base their decisions on future earnings prospects, which have been optimistic in the case of airlines. Investors have accorded impressive price/earnings multiples to the airlines because of their dramatic historical growth performance. As a result, airlines have been able to raise funds through equity financing. However, in the last five years the growth in airline traffic has been slow and unpredictable. The glamour in this industry has waned, and the price/earnings of many airlines' stocks have been reduced. New vibrance and growth must be restored to the industry before it is able to raise funds with equities.

Energy supplies are a critical factor that will play an increasingly important role in the vitality of this industry, and therefore, the ability of transportation companies to attract investment capital. For many transportation carriers, energy expenses are a major component of total operating expenses. Because of the leveraged nature of the business, changes in the price of fuel or electricity have major implications on operating expenses and profit margins. Furthermore, the patronage of each mode is decidedly affected in several ways by this phenomenon. One effect--with detrimental implications--is the added volatility and uncertainty in the performance prospects of the carriers due to the unknowns of energy prices. Some transportation enterprises are affected quite severely by increases in fuel prices (e.g., Trans World Airlines). Fuel inflation can wipe out profit margins, precipitate fare increases, and lower load factors. The differential magnitude of these impacts, as compared to the original fuel price rise, is serious enough that managements are desperately seeking out techniques that will decrease vulnerability to inflation. Therefore, attractive investments are ones which increase fuel consumption efficiency. In addition, funds are safer in projects that will not be obsolescent if fuel prices increase further.

Public Sector Involvement

In theoretical terms, the government assumes an active role when the objectives of private sector firms are not in consonance with public objectives. It is vitally concerned because transportation provides substantial benefits to the public in general, to wit, ubiquity of facilities, availability of common-carrier services, national defense needs, efficiency of resource allocation, and unification of the society and economy. In addition to providing many "spillover" or external benefits, this industry is a *natural* concern of the public--economists call it a public good--and the public policy objective is to ensure that the service levels of the industry meet the public need.

Historical Development of Government Involvement. Federal government authority to intercede in transportation flows from the constitutional power to regulate interstate and foreign commerce. The century-old Interstate Commerce Act is the milestone marking the assertion of federal authority in transportation. Section 77 was added to the Bankruptcy Act to deal exclusively with railroad bankruptcies; the Civil Aeronautics Board was established to regulate airlines; AMTRAK was created to finance and provide intercity rail passenger service; the Regional Rail Reorganization Act was enacted to reorganize the Northeast railroads.

The states made their imprint on intercity transportation by playing a major role in the establishment of canals and turnpikes in the first half of the 19th Century. Pennsylvania financed and constructed its turnpike--one of the first modern highways in North America. The Bay Area Rapid Transit District was established to finance and operate a metropolitan rail rapid transit system. The Port Authority of New York and New Jersey owns and operates the major New York City area airports and bus terminals.

In general, methods of public intercession into transportation may involve one or another of the following items:

- Ownership
- Financing
- Subsidization
- Taxation
- Regulation
- Competition
- Input supplies
- Research and development

Public vs Private Ownership. A latent, but fundamental, issue regarding the governmental role in transportation is whether or not direct public ownership, operation, and financing are necessary as in the current process of reorganization of the Northeast railroads. One

approach is that the problem is best solved via massive federal funding to purchase, rehabilitate, and operate most of the bankrupt lines. An alternative is that the solvent members of the industry possess the financial clout and have the responsibility to assume the burden of reorganizing the Northeast railroads. Of course, federal involvement is unavoidably necessary for rehabilitation, but is it necessary that the federal government purchase the properties, too? Must the public sector assume all the responsibility for the reorganization?

If the private sector can operate the enterprise with the proper incentives and can provide an acceptable quality and quantity of service, then why should the government expend funds to do what private enterprise can do? Is a superior choice that which minimizes the government role and leaves the industry in private hands? Certainly, the powers of regulation, taxation, and financing give the government the ability to shape solutions to many problems, resorting to nationalization as a last choice.

In addition to its application to rail reorganization, this issue has arisen in the airline industry in the past and will again. For example, the United States' representatives in international air commerce could very easily be candidates for nationalization. Do viable private sector alternatives exist?

To try to resolve this issue one must be cognizant of the broader concept of the transportation network as a public asset. Transportation systems, especially the fixed infrastructure, provide very great benefits to the general public some of which are availability of regularly scheduled common-carrier service, dependability, low cost, and the value of a good transportation system as a catalyst to commerce. Because of the public interest, the government must take an active role in the industry, and government ownership is particularly relevant to parts of the transport process which are not attractive as private enterprise investments. One such component is the infrastructure. The fixed plant and structures required to enable vehicular operations usually are extremely capital intensive. Furthermore, the capacity for output of the infrastructure facilities is such that they are naturally monopolistic. Thus, high output at low average costs is often in the public interest, but may not be attractive to a private operator. Consequently, the highway, waterway, airport-airways, and bridge infrastructures which serve private enterprise carriers are government-owned, and one of the key issues for the future is whether this concept can be extended to railroad rights-of-way and structures.

Subsidization. An issue emanating from the public-versus-private-ownership debate is that of subsidization, which is often used as a technique to avoid a total financial takeover by the public. The government has the power to mandate transfer payments from one sector of an industry or the economy to another. Revenue from taxes or borrowing can be assigned to finance continued or improved transportation

services, lower fares, rehabilitation, or R&D. Direct and indirect subsidies exist in all modes. Direct subsidies are received by local air service carriers with the rationale that their services on low-density routes are in the public interest. Indirect subsidies are payments which do not reflect real costs as in the highway system, in which operators of heavy vehicles may pay fees which are less than the investment and maintenance required to bring highway facilities up to required standards.

Cross-subsidization is a key public policy issue. Unlike the above cases where a subsidy is transacted between two parties (e.g., contract, user charge), cross-subsidies occur on an intracorporate level. For example, United Airlines undoubtedly cross-subsidizes its Salt Lake City-Ely-Elko-Reno-San Francisco service out of its overall profits. Economists traditionally bristle at the concept of cross-subsidization since it automatically implies that total corporate output and efficiency are distorted by unprofitable activities. In contrast, public policymakers embrace the concept as a way to induce firms to provide a socially desirable service in exchange for a reward elsewhere. Thus, through incentives and regulation, the common carriers can earn total profits which are fair, and yet provide services to the public which would not otherwise be available in a laissez-faire environment. The basic issue is whether the sacrifice in economic efficiency is worth the enhancement in the well-being of society.

In some areas of transport, private enterprise is almost completely incapable of providing acceptable service levels. For example, metropolitan rail transportation receives massive federal-state-local assistance. Because losses are being fully borne in the public sector, virtually all capital needs are financed by the public. Thus, capital subsidies and grants are provided to rapid transit systems, railroads, and AMTRAK for equipment modernizations.

In quasi-public sectors of transport in which a modicum of private enterprise motivations still exist, guarantees of debts may be sufficient inducements to elicit investments in some assets. In the future, the federal government may be increasingly called upon to guarantee the debt needed to finance R&D in new aircraft technology, acquisition of new aircraft, purchase of buses for light-density routes, etc. As an alternative to guarantees, the government could subsidize the debt service on worthwhile capital investments. Special tax credits, exemptions from taxation on interest, and outright sharing of interest expenses are several techniques by which investable funds might be attracted.

Asset Life Problem. Because of high interest rates, managers of private enterprises and their investors are not able to commit financial resources to investments in assets with service lives extending much beyond 20 years. At 6%, the present value of a stream of $100 per year from 1990 to 2010 is $480. If the discount rate more realistically

reflects the cost of private sector funds, say 10%, then the value of the flow is only $180. The time horizon for investments in railroad roadbeds and electrification, highways, bridges, tunnels, and airport facilities extends 20 to 50 years or more into the future. In private industry, it is irrational to invest in long-term projects such as rights-of-way unless acceptable profits can be earned within 10 to 15 years. Therefore, the government must provide the long-range risk sharing which is required to implement these investments.

The most attractive investments are those whose risk-return characteristics promise profits in the near future. Thus, the concentration of private investment activity into equipment is obvious. Equipment, unlike fixed infrastructure, usually has a service life of 5 to 15 years. For example, most airframes purchased new are depreciated over a 12- to 15-year life. Thus, private investors can be attracted to investments with forecastable cash flows extending into the "reasonable" future.

The most obvious technique of government assumption of these responsibilities is outright ownership. The airport-airways system is owned by the government, and it is operated by the Federal Aviation Administration and various public airport operating authorities. In the future, the federal government is slated to acquire Penn Central's Northeast Corridor passenger route from Boston to Washington. A government agency, probably AMTRAK, will maintain and operate the facilities. More public ownership of the fixed plant is certainly expected in the coming decades.

Related to the issue of service life, the choice of an accounting system for the enterprise is an important financial issue. A subtle, but very critical problem in transportation is the misstatement of service life of an asset. Whether the enterprise is public or private, the assets should be depreciated in conformity with generally accepted accounting principles (GAAP). Too often, accounting systems do not provide for depreciation of the facilities at rates reflecting real conditions. One finds airports earning purely illusory profits on facilities which, because of technological developments, were prematurely obsolete long before the revenue bonds which financed them were retired. The ICC uniform system of accounts for railroads does not even depreciate roadway, ties, rail, and other structures! Railroad managements and investors have no way of determining wear and tear; to make intelligent investment decisions, they must understand the depreciation costs of their infrastructure. Fruthermore, investors--whether private or government--must be informed of the performance of the enterprise. Information must be understandable and reflect, as best as possible, actual conditions. An accounting system which does not accurately reflect the actual service life of the assets cannot function as a management information system.

User Charges. User charges are used to raise revenues to pay for the operations and debt service of government-owned facilities. Because many transportation assets owned by the government has user charges, this form of revenue collection is, in and of itself, a financial issue.

Because most assets having user charges are complex capital-intensive facilities, the problem of equitable distribution of the burden arises; that is, which users will pay what portion (if any) of the operating and capital costs? The airport-airways system is shared by commercial, general, and military aviation users. The railroads' users are freight traffic, commuter, and intercity passenger traffic. The obvious controversy is: by what methodology shall common, or "joint," costs of the facility be apportioned among the users.

Several key issues are germane. Which costs are common? What is an avoidable cost? Who is the primary user? What is the index of apportionment? Should ability to pay be a consideration? Should the user charges be an instrument of public policy? Should incentives be included? Should congestion be a factor in pricing?

In practice, user charges are usually collected by a system of fees, charges, tolls, licenses, taxes, rentals, etc., the aims being to collect revenues to meet the financial needs of the facility and to distribute the burden in a fair manner. Probably, the key issue associated with this concept is: should these charges be used as a means of furthering public policy objectives? A subsidiary issue is the need to develop policies with respect to the external costs associated with the operation of the enterprise. An example of external costs is the noise and air pollution generated by users of airports. As the public role in transport expands, policymakers will be under increasing pressure to "internalize" such costs. Thus, they will have to develop techniques for assessing users for these external costs, and then this compensation will have to be transferred to those upon whom these costs have been imposed.

User charges can be assessed so that they subsidize implicitly some or all users. For example, when common costs are borne by only some of the users, the others receive the benefits of being treated as a by-product; that is, they pay incremental costs only (which are lower); thus, a cross-subsidy exists. Another form of subsidy is the airport authority which earns profits from airport operations which are used to pay for unrelated projects of the owning authority. In the opposite case (e.g., AMTRAK), user charges may not be sufficient to pay all operating and capital costs; the public policy determination is made that the service or facility is socially desirable and that the general public benefits from making up the deficit.

Financing by the Federal Government. As in the past, future public sector financing of transportation will be largely borne by the

federal government because it is the only sizable institution with the statutory authority to finance commitments of these magnitudes, the power to raise capital, and the ability to take a broad view transcending political subdivisions. Of course, the federal government has shortcomings too. For example, though it can take a broad geographical view of transport needs, its political policymakers do not receive any benefits from analyzing all public-investment requirements in a long-term context; Congress and the administration look for immediate results, and transportation policy priorities shift with each Congress. Thus, rational long-term transportation planning is impeded by vacillating political conditions.

One principal issue underlies the concepts of user charges, subsidies, and outright ownership. In essence, the federal government as provider of funds must make a policy judgment as to what sectors of the populace and industry shall receive financial assistance. Furthermore, the federal government must raise these funds in some way; therefore, it must set a policy for distribution of the burden. For example, subsidization of local air service reflects a policy to use federal funds to benefit small communities that would not otherwise receive service. State and local policy participation is minimal. In this case, the federal government has interceded in matters that largely impact a particular locality or region.

A thorny issue is policy manipulation by federal agencies at the local level. Clearly, subsidization of local air service is an assertion of federal influence over regional matters, and of course, this can be justified on the grounds of the federal mandate to improve transportation as empowered by the interstate commerce clause of the Constitution. In order to avoid excessive intrusion on state and local affairs, however, the federal government leaves many public sector investment decisions to officials at the state-local-regional levels. Very simply, federal authorities delegate their power through matching funds programs; federal financing in available, but planning and implementation are carried out at lower levels of government.

This delegation of authority via the matching funds mechanism does have some serious flaws. Outright grants of so-called matching funds distort the investment process. First, they bias the cost/benefit ratios of projects since the cost to the local government is perceived as its share of the budget only. Many a public investment undoubtedly generates less benefits than the sum of all the contributed costs, yet produces for the local government a very attractive return on *its* investment. There is bias in favor of capital-intensive solutions to needs. The excessive reliance on capital is due to the federal financing of fixed assets only, without funding for maintenance and operating expenses. Fixed assets are made cheaper relative to variable inputs. Thus, the local government will select projects that make use of this fixed-asset assistance in order to minimize its own total obligations of capital and operating expenses.

Another bias caused by matching funds is the absence of incentive to implement innovations in institutional practices and marketing. Since federal assistance is limited to asset acquisition (i.e., hardware), most projects deemphasize innovations in procedures, operations, service levels, and pricing (i.e., software).

Indeed, a critical issue is whether the federal government should use its resources to finance technological innovations. Often improvements in transportation are contingent upon achievement of technological breakthroughs. However, as the magnitude of these R&D efforts increase, the private sector becomes increasingly reluctant to assume the substantial front-end financial commitment. One observes an increasing requirement for public sector assistance in financing the research and development of airframes and turbine engines. The concept of federal assistance for innovations, software, technological changes, and marketing is an issue that is likely to become increasingly visible in the future.

Principal Questions of Future Policy

The nature and extent of public sector financing of intercity transportation will be one of the principal issues during the coming decade. Demands upon the government for infrastructure financing, operating subsidies, and outright ownership will increase. Will the government respond with an expansion of its ownership? Or will it seek out innovative inducements and regulatory policies designed to preserve private enterprise as the principal source of transport services? What role will the government assume in the rationing of funds or control of investments in the event of serious shortfalls in investable funds? Is nationalization preferred over elaborate schemes of subsidy aimed at the private sector? Is cross-subsidization an acceptable technique for advancing public policy? Should user charges be assessed as a technique of furthering public policy?

VII. THE COST-REVENUE SQUEEZE IN HIGHWAY FINANCE

by

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ABSTRACT

This paper discusses the troubled future of highway finance and identifies a number of factors that seem likely to aggravate the cost-revenue squeeze facing highway construction agencies.

The increasing fuel efficiency of private automobiles and the declining growth rate of vehicle-miles traveled (VMT) both suggest that a fixed-rate gallonage tax on gasoline (a primary revenue source) will be unable to keep pace with inflationary increases in the cost of highway construction and maintenance.

Inefficiencies in highway resource allocations will aggravate the squeeze. These inefficiencies include formula allocation, patronage-related problems, and political gamesmanship in project selection and programming. These factors will limit the ability of highway planners to match dollars and "needs."

Replacing the gasoline tax will be a major policy issue in highway finance, as will the dollar magnitude of revenues needed. Because maintenance costs are outpacing revenue growth, substantial pressures exist to relax federal restrictions on the use of federal funds for maintenance purposes; relaxation of these strictures would be likely to pinch construction programs further. If Congress approves a Unified Transportation Fund with local discretion in the use of some gas tax funds between modes and between capital and operating expenses, the fiscal woes of urban transit could spill over and constrict the revenues available for new highway construction.

Congress will be unable and unwilling to restore the highway construction program to its "place in the sun." Restoration of the Highway Trust Fund's 1965 buying power would require an additional 4.5¢ in federal gas taxes and an average 8¢ increase in state levies. New funding is likely to be approved at a level sufficient to achieve a gradual, rather than precipitous transition in program content and level; Congress also seems likely to approve a revenue-sharing feature in new legislation, give priority to completion of the Interstate, and curtail the proliferation of highway program categories.

The most wrenching problem of revenue constriction appears to be making the institutional transition from the administration of a large-scale construction program to the orderly and efficient management of maintenance and rehabilitation of operations. Service deficiencies are also likely. They will appear gradually as problems of urban area capacity and intercity route maintenance and rehabilitation.

Large-scale capital improvements will, inevitably, be postponed. Technologies such as electrified highways, which improve service quality but impose cost penalties, seem unlikely to be implemented in this fiscal setting.

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In short, the successful transition from project engineering to system management is of prime concern as a result of the cost-revenue squeeze in highway finance.

VII. THE COST-REVENUE SQUEEZE IN HIGHWAY FINANCE

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VII. THE COST-REVENUE SQUEEZE IN HIGHWAY FINANCE

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Introduction

This paper discusses the troubled future of highway finance and identifies a number of factors that seem likely to aggravate the cost-revenue squeeze facing highway construction agencies.

The increasing fuel efficiency of private automobiles and the declining growth rate of vehicle-miles traveled (VMT) both suggest that a fixed-rate gallonage tax on gasoline will be unable to keep up with inflation-paced increases in the cost of highway construction and maintenance. Replacing the gasoline tax will be a major policy issue in highway finance.

So will the dollar magnitude of highway taxes. This paper argues that Congress will be unable and unwilling to restore the highway construction program to its "place in the sun." (Restoring the Trust Fund's 1965 buying power would require an additional 4.5¢ in federal gas taxes and an average 8¢ in state levies.) This argues that highway agencies should view their primary planning task as the orderly management of institutional transition. Rehabilitation, maintenance, and operations will assume increasing importance, while the construction function contracts.

The research agenda appropriate to this transition era would be keyed to the efficient management of maintenance and rehabilitation functions. It will be extremely difficult for bureaucracies designed to execute the expansion of capital facilities to make this transition while retaining the qualified personnel they have recruited in the past.

Technologies such as electrified highways, which improve service quality but impose cost penalties, seem unlikely to be implemented in this fiscal setting. This argues that the R&D premium should be placed on cost-saving techniques rather than service-enhancing technologies.

Recent Trends in Highway Finance

The predominant source of revenues for highway construction and maintenance is the gallonage tax on gasoline. The gas tax--levied by both federal and state governments--is assessed on a per-gallon basis which increases with fuel consumption but not inflation.

In the 1950s and early 1960s, VMT, fuel consumption, and inflation increased at approximately the same rate, permitting a vigorous program

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of highway construction funded by a 4¢ federal fuel tax and state gas taxes averaging 7¢.

Since the mid-1960s, construction costs have far out-paced the growth in highway revenues, although this trend was somewhat disguised by the declining fuel economy of the automobiles marketed between 1965 and 1974. In that ten-year period, the Federal Highway Administration (FHWA) Construction Cost Index increased 111 points, or the equivalent of an additional 4.5¢ in federal gasoline taxes and an additional 8¢ in state levies.

Table VII-1 shows the escalation of a 7¢ state gasoline tax that would have been necessary to keep pace with various cost indices during the past decade. During the period actual gas tax rates remained stable with the exception of 1¢ increases in a handful of states. Much of the increment in gas tax revenues from increased VMT was required to offset the increasing cost of highway maintenance and rehabilitation. This has led highway agencies to argue that current tax levels are inadequate even for the near future and that "the nation's non-Interstate street and highway network is wearing out twice as fast as it is being replaced."*

The Gloomy Future of Highway Finance

While it is unlikely that construction costs will continue to escalate at their recent rate, a number of factors are likely to aggravate the cost-revenue squeeze which is battering the construction program of highway agencies across the country.

Fuel-Efficient Vehicles. The Energy Policy and Conservation Act of 1975 mandates substantial fuel-economy improvements for 1985 cars. The federal legislation calls for 1985 models to achieve an average of 27.5 miles per gallon on a sales-weighted basis. If highway taxes remain pegged to gallonage, the implication is stable or declining revenues through 1990. Using FHWA estimates of the fuel consumption of the 1990 vehicle fleet, one must conclude that each 1990 VMT will generate approximately 0.5¢ in highway tax revenues compared to today's 0.8¢ (assuming a constant gallonage tax).

Table VII-2 shows the calculations behind the FHWA's "no-growth" scenario for gasoline consumption. The scenario assumes that the 1990 vehicle fleet obtains an average fuel efficiency of 20.4 miles per gallon and that VMT grows at an annual compound rate of 2.2%.

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*Illinois Department of Transportation, proposal for a "Surface Transportation Act of 1975," undated monograph.

Table VII-1.

TAX RATE IMPLICATIONS OF AN INDEXED GAS TAX

Year	Consumer Price Index	Consumer Price Tax (cents)	Wholesale Price Index	Wholesale Price Tax (cents)	WPI-Industrial Index	WPI-Industrial Tax (cents)	FHWA Index	FHWA Tax (cents)	Engineering News Record Index	Engineering News Record Tax (cents)
1963	91.7	7.00	94.5	7.00	94.7	7.00	86.4	7.00	90.1	7.00
1964	92.9	7.09	94.7	7.01	95.2	7.04	86.9	7.04	93.6	7.27
1965	94.5	7.22	96.6	7.15	96.4	7.13	90.3	7.32	97.1	7.55
1966	97.2	7.42	99.8	7.39	98.5	7.28	96.1	7.78	101.9	7.92
1967	100.0	7.64	100.0	7.41	100.0	7.39	100.0	8.10	107.0	8.32
1968	104.2	7.95	102.5	7.59	102.5	7.57	103.4	8.38	115.5	8.97
1969	109.8	8.38	106.5	7.89	106.0	7.83	111.8	9.06	126.9	9.86
1970	116.3	8.88	110.4	8.18	110.0	8.13	125.6	10.18	138.6	10.77
1971	121.3	9.26	113.9	8.44	114.0	8.43	131.7	10.67	158.1	12.29
1972	125.3	9.56	119.1	8.82	117.9	8.72	138.2	11.20	175.3	13.62
1973	133.1	10.16	134.7	9.98	125.9	9.30	152.4	12.35	189.7	14.74
1974	147.7	11.28	160.1	11.86	153.8	11.37	201.8	16.35	201.9	15.69

Note: All indexes are annual averages.
All indexes are 1967 base except *Engineering News Record* with a 1973 base.

Source: California Department of Transportation, Division of Transportation Planning

Table VII-2.

ESTIMATED VEHICLES, TRAVEL, AND GASOLINE CONSUMPTION

Year and Automobile Size	Number of Automobiles (millions)	Annual Miles per Vehicle	Total Vehicle-Miles (billions of automobiles)	Miles per Gallon	Total Gasoline Consumption (billions of gallons)
1972					
Standard	63.0	10,370	653.3	12.0	54.3
Compact	22.0	10,000	220.0	16.0	13.7
Economy	11.9	9,500	113.1	22.0	5.1
Total	96.9	10,184	986.4	13.49	73.1
1980					
Standard	57.1	9,700	554.1	13.1	42.3
Compact	30.9	10,100	312.1	17.0	18.4
Economy	39.5	9,700	286.2	23.0	12.4
Total	117.5	9,800	1,152.4	15.8	73.1
1985					
Standard	36.8	10,950	403.1	14.5	27.8
Compact	40.2	10,600	426.1	17.5	24.3
Economy	50.4	10,000	504.0	24.0	21.0
Total	127.4	10,460	1,333.2	18.2	73.1
1990					
Standard	21.8	11,700	255.1	16.0	15.9
Compact	40.7	11,100	451.8	18.0	25.1
Economy	73.8	10,650	786.4	24.5	32.1
Total	136.3	10,950	1,493.3	20.4	73.1
1990/1972 Growth Increments	+40.7%	+7.5%	+51.4%[a]	+51.7%	0.0%

a. 2.2% compounded annually.

Source: FHWA, "Highway Travel Forecasts," November 1974.

Increasing the assumed VMT growth rate to 2.9% produces a 1990 fuel-consumption level that is only 10.0% greater than that of 1972. Reducing the assumed VMT growth rate to 1.9% produces a 1990 gasoline consumption estimate that is 7.3% *lower* than occurred in 1972.

Increasing Maintenance Costs. During the past decade, maintenance costs have escalated at a compound annual growth rate approximating 5.2%. It seems likely that this rate will continue, outpacing future revenue growth. The factors which are driving the cost of maintenance upwards include: aging roads, streets, and structures; increased roadway mileage; increasing vehicular travel; increased level of effort represented by policies toward lighting, snow removal, beautification, and environmental mitigation.* Economies can be achieved in the latter areas and, over the short term, through deferred maintenance.

There is already substantial pressure to relax congressional restrictions on the use of federal funds for maintenance purposes. The relaxation of statutory restrictions would be likely to pinch construction programs even further.

Table VII-3 shows the escalation of operation and maintenance costs and their claim on state and local program budgets.

Declining Rates of VMT Growth. In the past decade, the annual growth rate of VMT has hovered between 4% and 5%. The FHWA predicts that this growth rate will level to a compound growth rate of 2.5% for the period 1970 to 1990. The reduced growth rate projection is the result of "the saturation of motor vehicle ownership, and possible reduction in long trips due to lower speed limits and higher fuel prices."** Reduced population growth also contributes to the reduced growth rate of VMT late in the projection period.

While fuel-efficient vehicles may counterbalance the effect of higher fuel prices, it seems likely that the growth rate of VMT--and therefore gas taxes--will fall behind both historical levels and escalation rates of construction and maintenance costs.

Modal Competition and Gas Tax Diversion. The 1973 Highway Act permits the diversion of High Trust Fund dollars from urban Interstate and "D" System routes for transit capital purposes. To date, diversion

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*Dean L. Morgan, "Nationwide Costs of Highway Maintenance and Operations," Highway Users Federation Monograph, January 1975.

**Federal Highway Administration, Office of Highway Planning, "Highway Travel Forecasts," November 1974.

Table VII-3

TRENDS IN HIGHWAY, MAINTENANCE, AND OPERATING COSTS

Year/Jurisdiction	Maintenance & Operations Expenditures (millions of dollars)	Total Highway Disbursements (millions of dollars)	Maintenance % of Total Disbursements
1965			
State	1,337	9,814	13.6
County & Township	1,080	2,020	53.5
Municipal	854	2,160	39.5
Federal	18	249	7.2
Total	3,289	14,243	23.1
1966			
State	1,433	10,765	13.3
County & Township	1,138	2,170	52.5
Municipal	893	2,405	37.1
Federal	52	358	14.5
Total	3,516	15,698	22.4
1967			
State	1,546	11,338	13.6
County & Township	1,205	2,317	52.0
Municipal	970	2,645	36.7
Federal	50	369	13.6
Total	3,771	16,669	22.6
1968			
State	1,624	12,303	13.2
County & Township	1,272	2,465	51.6
Municipal	1,066	2,843	37.5
Federal	42	372	11.3
Total	4,004	17,983	22.3
1969			
State	1,759	12,630	13.9
County & Township	1,392	2,664	52.3
Municipal	1,136	3,127	36.3
Federal	43	353	12.2
Total	4,330	18,774	23.1

Table VII-3 (Cont.)
TRENDS IN HIGHWAY, MAINTENANCE, AND OPERATING COSTS

Year/Jurisdiction	Maintenance & Operations Expenditures (millions of dollars)	Total Highway Disbursements (millions of dollars)	Maintenance % of Total Disbursements
1970			
State	1,967	14,100	14.0
County & Township	1,463	2,864	51.1
Municipal	1,240	3,440	36.0
Federal	50	431	11.6
Total	4,720	20,835	22.7
1971			
State	2,140	15,246	14.0
County & Township	1,566	3,055	51.3
Municipal	1,352	3,683	36.7
Federal	63	496	12.7
Total	5,121	22,480	22.8
1972			
State	2,281	15,548	14.7
County & Township	1,655	3,250	50.9
Municipal	1,435	3,900	36.8
Federal	49	528	9.3
Total	5,420	23,226	23.3
1973			
State	2,534	15,356	16.5
County & Township[a]	1,740	3,450	50.4
Municipal	1,528	4,137	36.9
Federal	51	577	8.8
Total	5,853	23,520	24.9
1974			
State	2,719	16,289	16.7
County & Township[b]	1,825	3,650	50.0
Municipal	1,616	4,342	37.2
Federal	50	556	9.0
Total	6,210	24,837	25.0

a. Preliminary
b. Estimate

Source: *Highway Statistics* - Summary to 1965. Table HP-202, pgs. 76-77.

has been extremely limited due, in part, to the capital-only restriction on substitution.

The 95th Congress will consider a number of proposals for a Unified Transportation Fund. The common characteristic of many of these proposals is their endorsement of local discretion in the use of some gas tax funds between modes and between capital and operating expenses.

If gas taxes are made available for transit operating purposes--even in a limited fashion--the financial position and political appeal of urban transit will become additional determinants of the dollars available for highway construction.

Even without further "trust busting," the financial position of urban transit has to be considered a factor that will influence the public funds available for highway improvements. Competition between cabinet-level domestic programs is fierce and imposes a de facto political ceiling on the revenues that Congress will spend for any one program function. Over the past decade, transportation's share of the budget has increased in absolute terms but declined relative to other domestic programs. Thus, when considering total expenditures for transportation, the share claimed by urban transit and AMTRAK are highly relevant to future highway authorizations.

Transit must be viewed as a source of continuing fiscal instability in the total transportation finance picture because the rate of escalation of transit operating costs exceeds the growth rate of almost every public tax source. Although operating deficit estimates are notoriously flimsy, it seems probable that the five-year *unfunded* operating deficit of urban transit will exceed $4 billion during the 1976 to 1980 period (if fares and public subsidy are held constant).* Thus, in terms of shares of the transportation "pie," it seems likely that the financial woes of urban transit will spill over and constrict the revenues available for new highway construction.

Institutional Inertia and Structurally Imbedded Inefficiencies. The structure of highway financing mechanisms and the behavior of highway programming bureaucracies has introduced allocative inefficiencies that have diminished the effective buying power of highway funds. These will be difficult to change and will probably continue to impose some misfit between dollars and deficiencies. Formula allocation is one source of dollar/deficiency disjunction. The programs of state

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*Rough estimate based on data in D. W. Jones, "Transit Operating Assistance," California Department of Transportation monograph, August 1975; Tri-State Regional Planning Commission, "Maintaining Mobility," September 1975; "APTA Transit Facts," American Public Transit Association, 1975.

highway departments continue to be distorted by the 90 to 10 matching rate of the Interstate program and the consequent scramble to maximize federal funds. Similarly, a strong case can be made that both state and federal funding formulas are creating an overcapitalized but undermaintained system of rural roads.

Another source of inefficient resource allocation is political gamesmanship in project selection and programming. Similarly, the patronage function of some highway departments will make it difficult to trim maintenance costs and achieve other program economies.

In combination, these factors are cumulating toward a cost-revenue squeeze of substantial and enduring proportions.

Highway professionals have already responded to the first signs of cost-revenue crisis with layoffs and urgent requests for new tax authority. The House Public Works Committee has promised to develop a comprehensive, long-range bill during the 95th Congress.

It seems unlikely that Congress will be able to unravel the problems of surface transport finance in a single session because it will be charting new and unfamiliar ground:

- A transportation system that is primarily characterized by problems of maintenance and operation rather than connectivity deficiencies.
- A transportation finance problem that no longer fits the administratively simple exigency of a gallonage tax on gasoline.
- An allocation problem which is confounded by modal rivalries and turf fights among state, local, and regional bureaucracies.
- A program area--transportation--that has declined from "motherhood-and-the-flag" status to one among many domestic programs.

Despite the complexity of the issues, Congress is likely to take some action, and it may be useful to speculate on its general shape and form. Based on a review of legislative proposals being developed at both the federal and state levels, it seems likely that the "next generation" of transportation legislation will do the following:

- Provide some additional revenue. Frequently discussed revenue sources include an indexed or per centum tax on gasoline and a waybill tax on freight.

- Include a "revenue sharing" feature. Most proposals provide for the subvention of some fraction of the Highway Trust Fund to localities--either states, regions, or municipalities--for discretionary expenditure between modes and between operating and capital costs.

- Give priority to completion of the Interstate and curtail the proliferation of highway program categories. Most proposals involve five or six program categories which keep intact the Interstate, Primary, and Secondary road programs in an effort to strike a balance between rural and metropolitan interests.

Clearly the most difficult challenges for legislative craftsmanship are posed by the declining viability of the gallonage tax as a revenue source and the difficulty of evaluating and monitoring benefits derived from highway maintenance and rehabilitation. The extent of discretion between modes, between cost categories, and the location of discretionary authority will also complicate the congressional politics of the next-generation transportation fund.

The complexity of these issues and the magnitude of operating and maintenance costs suggest that Congress cannot restore the highway construction program to its "place in the sun." But it also seems unlikely that Congress will allow the highway program to be precipitously dismantled by the cost and revenue trends discussed above. It seems reasonable to expect enough funding to achieve a gradual, rather than precipitous, transition in program content and level. This outcome seems more likely than either hefty new taxes or "benign neglect."

The Implications of a Contracting Construction Budget

The more wrenching impacts of revenue constriction appear to be bound up in the problem of institutional transition rather than service deficiency.

The bureaucracies which conduct highway research, planning, and programming have been staffed and structured to execute and administer a large-scale construction program. They are largely ill-equipped and unmotivated to perceive "needs" and "deficiencies" in terms of the less-than-glamorous activities of maintenance, rehabilitation, and operational efficiency. The highway bureaucracy was created to "build" solutions, not to manage operations and maintenance activities.

Thus, the process of institutional transition will be particularly painful: professional advancement has traditionally been keyed to accomplishments in project development; funding mechanisms and budgeting methods have developed in a project, rather than program, context; the highway professional's claim to political influence and public funds has been built on the ability to deliver projects that stimulate

local economic growth; and, most fundamentally, the maintenance and rehabilitation functions are perceived as banal, humdrum, and commanding little political support.*

Revenue constriction *will* produce service deficiences--again, not precipitously, but gradually. These are most likely to take the form of aggravated capacity deficiencies in urban areas and maintenance deficiencies on intercity routes. Gap-filling projects will slip and deficiencies in safety will accumulate.** The magnitude of these service deficiencies will depend only in part on the absolute magnitude of available revenues. Expenditure flexibility--both de jure and de facto--will be a very important factor in determining the buying power of available funds. Program categories, formula minimums, and the informal fair-share politics of the highway budgeting process will probably exaggerate the effects of revenue constriction on the quality of service. This again is a problem of institutional evolution.

Revenue constriction will inevitably mean the postponement of large-scale capital improvements. Technologies such as electrified highways and high-speed ground transportation which involve service improvement but cost penalties will be deferred or discarded. They represent an R&D agenda appropriate to an era of expansion--not contraction. The same logic suggests that a declining rate of innovation and capital development will make it difficult to attract and retain qualified professional personnel.

Thus, it appears that the most significant implication of constricted construction budgets is a problem in staffing and management--a problem that is bound up in making a successful transition from project engineering to system management. Guiding this transition and maturing and legitimizing the techniques of system management appear to be the highest priorities of highway research.

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*A substantial misperception; in actuality, system operation requires far more complicated and dynamic modeling and control capabilities than construction engineering.

**A judgment call based on a critical reading of the 1972 National Transportation Needs Study and recent interviews with state planning officials in California, Illinois, and Massachusetts.

VIII. INTERACTIONS BETWEEN CAPITAL FUNDS SOURCES AND TECHNOLOGICAL CHANGES IN RAIL AND AIR PASSENGER TRANSPORT

by

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ABSTRACT

This paper traces trends in costs and revenues for intercity rail and air transport and translates these trends into implications on the sources of capital for these industries and on related technology, service levels, and market shares.

The most fundamental shift in intercity transport during the next 50 years will be a decline in the growth rate of air transport. By 1969, a full-fledged "recession" in air travel was apparent. Trends in costs, however, did not decelerate as quickly as revenues, thereby seriously hurting profits. The problem of the air transport industry is not so much the ability to raise capital, as it is the ability to maintain a viable level of operations to ensure long-run solvency and investor confidence.

The airlines' traditional major sources of capital which are affected by the industry's viability are the following: public financing (the largest source of funding), institutional investors, mortgages, commercial loans, convertible bondholders, income bonds, hedge funds, financial intermediaries, equities, and accounts payable.

The airlines are not projected to become destabilized and enter into wholesale bankruptcies. The narrowing of the gap between revenues and costs is expected to be halted.

Two techniques exist to rectify air transport's plight. The first is the "bail out": fare increases; route swaps; mergers; direct subsidies, e.g., local service airline-type subsidies; indirect subsidies, e.g., noncompensatory landing fees; regulatory protection; and government purchases of securities.

The second solution is to increase the productivity of the airlines. Increasing productivity has been the railroads' problem since modal competition affected their monopoly. For the railroads in the past, and the airlines in the future, the bad years are those in which wage rates climb faster than productivity increases.

The glamour years of the 1960s are over for the airlines. The next 50 years do not promise lucrative or dramatic innovations. The most obvious focal point of innovative activities is the landside portion of the air travel production function: maintenance performance through improved management (better inventory, station location, and supervisory techniques); and better trained mechanics; further automation of ticketing, reservations, passenger information systems; aircraft servicing; and cargo handling.

Air travel is expected to remain an income elastic product (at least for pleasure travel, the fastest growing portion of the air market); but growth rates will not parallel those of the 1960s. Improved airline

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productivity will come from tightened managerial controls over expenditures and performance. The technology of the future will be less exotic and more oriented toward labor-saving innovations on the landside. "No frills" services can also be expected.

AMTRAK's future is unlike that of the airlines, because this rail passenger carrier receives virtually all of its direct funding from the public sector. AMTRAK's public funding is deemed worthwhile, since the service provides important benefits to nonusers. Its long-haul services are justified because of the need for common-carrier transport to cities without air service. And political pressures for continuation of these services exist in spite of massive operating deficits.

As for Northeast Corridor services, the density of rail travel is projected to increase rapidly in terms of both absolute passenger-miles and market shares, as a result of a federal policy commitment to upgrade the frequency, speed, reliability, and comfort of rail travel in the Boston-Washington corridor.

The principal use of federal AMTRAK funds during the next 50 years will be to finance high-performance equipment, with some investment being channeled toward modernization of facilities.

Probably the biggest area of controversy during the next 50 years will be in the context of maintenance and control over the right-of-way. Already, AMTRAK is moving toward the takeover of the Penn Central's main Boston-Washington line. In corridors where passenger operations are secondary to freight usage, AMTRAK will continually be conflicting with the freight operators over operating speed limits, slow orders, delays, and ride characteristics. The freight railroads have no profit motive for maintaining roadbeds at levels commensurate with AMTRAK's goals of high-speed, high-quality service.

Several potential solutions for the conflict are the following: nationalization of the freight rail system; renegotiation of the user charges paid by AMTRAK to the freight railroads; AMTRAK funding of new equipment technologies not required as high standards of roadbed conditions to permit high-speed operations; or AMTRAK acquiescence by operating at low-speed or discontinuing services.

So long as rail passenger services are deemed in the public interest, funds will be available for equipment, infrastructure, information systems, maintenance, and terminals. The future of intercity passenger technology, service qualities, and market share is inextricably bound up in the federal commitment to fund AMTRAK.

VIII. INTERACTIONS BETWEEN CAPITAL FUNDS SOURCES AND TECHNOLOGICAL CHANGES IN RAIL AND AIR PASSENGER TRANSPORT

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VIII. INTERACTIONS BETWEEN CAPITAL FUNDS SOURCES AND TECHNOLOGICAL CHANGES IN RAIL AND AIR PASSENGER TRANSPORT

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Introduction

Technological changes in intercity rail and air transport are expected to be heavily influenced by the sources of capital that will fund each mode. The principal issue facing the airlines is whether they can successfully introduce technological innovations to the *landside* portion of their production function. They must halt the cost growths which are outstripping increases in patronage and revenues. Otherwise, the trends of the last five years may continue. These trends are inherently unstable. The industry cannot remain solvent and retain investor confidence.

Railroad intercity passenger transport is entirely different; here, new technology is virtually exclusively dependent on fiscal support of AMTRAK from the public sector.

This paper traces trends in costs and revenues for carriers in these two modes. It translates these trends into implications on the sources of capital for the industry. In other words, will capital remain available? In turn, the discussion identifies probable changes in the cost and revenue trends which must be made in order to meet industry goals. Implications on technology, service levels, and market shares are suggested.

Common-Carrier Air Transport

During the next 50 years, perhaps the most fundamental shift in intercity transportation that will occur will be a decline in the growth rate of air transport. The last 25 years has witnessed the emergence of air travel from a relative novelty to a virtual way of life for large sectors of the American population. In 1955, the number of passengers equaled 34.5 million. By 1974, the number had quadrupled to 148 million. On Wall Street, air transport was the Cinderella of the 1960s, the period in which its most dramatic and robust growth occurred. Table VIII-1 depicts the annual rates of growth of available seat-miles and revenue passenger-miles from 1955 through 1968 for domestic trunk carriers. The table also extrapolates these growth rates from present day (1974 base year) levels into the year 2000.

In 1968, any continuation of past trends meant a rosy future. However, by the late 1960s, the first cloud began to appear on the horizon of the industry's unbounded rates of growth. By 1969, a full-fledged "recession"

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in air travel had set in. When the bubble burst, the rate of growth in air travel declined dramatically from the 11% range down to around 4%. Table VIII-2 shows the rates of growth for capacity and patronage during the period 1969 to 1974.

Table VIII-1

GROWTH IN AIR TRAFFIC
Pre-1968

	Available Seat-Miles	Revenue Passenger-Miles
1955-1968 Annual Growth Rates	12%	11%
1974 Base Traffic (in millions)	211	117
Year 2000 Traffic (in millions)	4,220	1,755

Source: *Moody's Transportation Manual*, 1975, p. a60.

Table VIII-2

GROWTH IN AIR TRAFFIC
Post-1968

	Available Seat-Miles	Revenue Passenger-Miles
1969-1974 Annual Growth Rates	2%	4%
1974 Base Traffic (in millions)	211	117
Year 2000 Traffic (in millions)	359	326

Source: *Moody's Transportation Manual*, 1975, p. a60.

The comparisons of Tables VIII-1 and VIII-2 are startling, to say the least. The rate of growth after 1968 slacked off so significantly that the revenue passenger-mile level by the year 2000 would be only one-fifth the amount it would be at if the pre-1968 growth rates continued.

The implications of this "correction" are very forceful. For example, in 1968--at the zenith of the high-growth era--a major trunk airline made a rather extensive forecast for planning purposes of its capacity as it would be in 1976. Based upon a 1967 index of 100, available seat-miles were forecast to be 300 in 1976 and 450 by 1980. In actuality, the 1976 figure was only 150. The carrier had projected massive investments in jumbo jets and SST aircraft. The amount of jumbo jets was well below projections, and no supersonic aircraft were purchased.

These statistics illustrate the fact that the air transport industry has been smacked hard by a downward revision of historical growth rates.

This corrective trend change has also brought to light several phenomena previously unapparent. The trends in costs did not decelerate as quickly as revenues. The last six years have not been good ones for the airlines, which have not been able to halt the growth in costs as fast as was necessary to maintain healthy profit levels. Flying operations--the principal category of actual transportation expenses--when measured in cents per revenue passenger-mile, has climbed from 1.66¢ in 1969 to 2.43¢ in 1974. The airlines opted to raise fares which drove the average revenue per passenger-mile up from a 20-year plateau (in the 5.5¢ range) to the unprecedented high of 7.24¢. During that period, the domestic trunk carriers' net income never attained the acceptable goals set by the Civil Aeronautics Board.

Since the slowed growth set in, the profitability of the industry has been below the levels required to remain solvent. Carriers have been forced to ground aircraft, furlough employees, endure protracted strikes, and scramble for ways to increase the output of their stock of assets. These events portend the trends of the 1980s and 1990s.

Essentially, the gap between revenues and costs is dangerously narrowing. The question arises as to how long cash flows can continue below acceptable levels. The industry must generate sufficient cash flows so as to remain solvent and maintain the confidence of its investors. Air transport, like most sectors of transportation, is not so much constrained by a need to raise capital from the private sector, as it is by maintaining the friendly backing of investors. The transportation industry stands out from most industries in this respect because, even bankrupt companies like the Penn Central are able to obtain equipment financing secured by equipment trust certificates, leases, or conditional sales agreements. In other words, some sources of capital are open to the weakest of airlines. However, such companies cannot remain solvent forever if they do not earn positive cash flows. Thus, the problem is not so much the ability to raise capital, as it is one of maintaining a viable level of operations needed to remain solvent in the long run.

C-3

Impact On Traditional Fund Sources. If, indeed, the airlines were not able to remain viable in the long run and were forced to restructure their financing, what would be the changes in the sources of funding? The following discussion lists each of the airline's major sources of capital and sets forth the probable impact on each due to a precipitous plunge in the viability of this industry.

- Public Financing--Probably the mode's largest single source of funding is the supplying of the airport-airways system by various levels of government. No matter what maladies may impact the common carriers, as long as air transport is deemed to be in the public interest, then public sector funding will be made available for fixed infrastructure. However, if the industry falters, its ability to generate sufficient user fees to amortize these expenses may be jeopardized.

- Institutional Investors--A downturn in the viability of the airlines could very seriously impair access to the institutional (insurance companies, pension funds, mutual funds) sources. These investors are usually oriented toward low-risk securities such as long-term debts, secured (mortgaged) debts, and other issues having dependable yields and a low probability of default. These investors typically supply funds for long-run operating needs, nonaircraft equipment, and buildings. A threat to solvency would heavily cut into these funds.

- Mortgages--Mortgages are not extensively used in air transport financings except when a loan is secured by a lien on assets of the company. If an air carrier encounters financial trouble, creditor demands for collateralization of loans will increase. The loan with a mortgage may become more commonplace. (Of course, many of the weaker airlines have already pledged most of their assets as collateral on various loans.)

- Commercial Loans--Commercial banks provide airlines with working capital loans which are often the most junior debts on the balance sheet. When the financial strength of the carrier declines, the access to this capital source evaporates. Thus, one observes the tremendous difficulty encountered by weak carriers, such as Pan Am, in their attempts to roll over short-term obligations. When collateral is exhausted, this source of funds will no longer be available if the industry cannot maintain an ongoing viability.

- Convertible Bondholders--This source of funds is usually provided by an investor willing to assume higher levels of risk in anticipation of a prospect of appreciation in the firm's equities. Convertibles have been a popular instrument of financing among the airlines in the past. If the highly leveraged condition of the industry continues in the future,

it is likely that this financial technique will be continued, as long as the tax laws allow deduction of interest expenses.

- Income Bond--This financial instrument, commonplace in railroad reorganizations, may emerge in the airline industry as a high-risk form of debt. Of course, the issuance of income bonds would probably emerge from some sort of financial restructuring of a weak company.

- Hedge Funds--This source of financing is used to acquire equipment and then lease, or otherwise convey to the carrier. The hedge fund is set up primarily to capitalize upon tax incentives to purchase transportation equipment and then to rent it out and take an accelerated depreciation deduction available under the Internal Revenue Code. The hedge fund will probably continue to be useful for airlines as long as their income tax liabilities are not sufficient to utilize the full amount of depreciation expenses that would accrue if they owned and financed their fleets.

- Financial Intermediaries--For the airlines this source of capital is the critical one. The airlines finance large portions of their equipment through leases, equipment trust certificates, and conditional sales contracts which are largely financed by insurance companies, bank trust funds, or leasing companies. These intermediaries are willing to provide capital to this industry, even in spite of financial adversities, as long as the equipment is adequate collateral for the loan. Thus, this important source of capital will remain open, albeit the cost of capital will probably rise, as long as some of the creditors are able to maintain control over the equipment in the event of default. (An important issue that will arise during the next 50 years is whether the creditors can, in fact, foreclose on these assets in the event of default. Mortgagees of railroad lines have been effectively thwarted in their ability to foreclose, and as a result, mortgage funds for railroads have effectively dried up. In airline bankruptcies, the treatment of creditors' rights versus the need for public transportation will be of critical importance.)

- Equities--During the high-flying years on Wall Street, the airlines were able to float common and preferred stocks, convertibles, and warrants. These higher-risk securities were readily accepted because of the expectation for continued buoyant profit growth. However, the latter quarter of this century will have to witness a profit revitalization, if the equity markets are to be reopened in any substantive way.

- Accounts Payable--Most corporations use accounts payable as a "float" to help generate cash. This technique will remain

available to airlines, but as their financial standing deteriorates, the ability to float payables becomes impaired.

Increasing Productivity. The airlines are not projected to become destabilized and enter into wholesale bankruptcies. The narrowing of the gap between revenues and costs is expected to be halted. There are two ways to correct these trends. The first technique is popularly known as the "bail out" which may consist of fare increases, route swaps, mergers, direct subsidies (e.g., local service airline-type subsidies), indirect subsidies (e.g., noncompensatory landing fees), regulatory protections, or government purchases of securities.

The other strategy designed to stave off insolvency is aimed at increasing the productivity of the airline production function. In practical terms, each unit of labor and capital would be expected to produce more revenue passenger-miles. The increasing of productivity has been the problem facing the railroads ever since intermodal competition cut into their monopoly position. The railroads have been forced to invest heavily in capital in order to increase the productivity of labor at a rate fast enough to exceed periodic wage increases. Historically, productivity of railroad labor has outstripped trends in wage costs thanks to heavy investment in capital. However, for the railroads in the past, and the airlines in the future, the bad years are the years in which wage rates climb faster than increases in productivity.

One reason why the airlines were the glamour industry of the 1960s was that the introduction of turbine-powered aircraft had a twofold benefit. The first was that this technological innovation dramatically increased the productivity of both labor and capital. Second, jets were a demand-stimulating service innovation. The next 50 years do not promise technological innovations as lucrative or dramatic as the new aircraft developments of the 1960s. If the airlines are to increase productivity, they must look to more mundane opportunities to innovate.

The most obvious focal point of innovative activities is the landside portion of the air travel production function. This round of innovations will not be concentrated on high technology, but rather will be composed of managerial controls, some new technology, plus better training of labor. For example, maintenance performance will be improved through management--inventory control, better location of stations, and more efficient supervisory techniques. In regard to technology, maintenance expenses will be lowered through less "downtime" in aircraft. Labor productivity will be increased if the skills of the mechanics can be refined even further and if the amount of man-hours required to perform a given task is decreased through innovations such as modularization.

On the landside, increased productivity will come through further automation of ticketing, reservations, passenger information systems, servicing of aircraft, and cargo handling. Several of these landside components of the production function are ripe for technological

innovations. For instance, baggage handling still utilizes 1940s technology. Several notable innovations have been introduced for sorting and distributing baggage. Frankfurt Airport (Germany) has instituted an advanced computerized sorting system. An American corporation, Docutel, has thus far not succeeded in establishing its technology of baggage sorting; but its experiences indicate the activity in the innovation process for this technology.

Implications for the Future. The rates of growth of patronage are likely to exceed national averages in other sectors of the economy simply because air travel is expected to remain an income elastic product (at least for pleasure travel which is the fastest growing portion of the air market). But these growth rates will not be like the 1960s; thus, improved airline productivity will come from increased managerial awareness of the expenditures required to produce a given service.

Tightened managerial controls over performance will probably precipitate a complete reevaluation of technology policy. In the past, technological innovations on both the airside and landside of the production function have been welcomed as tools to stimulate demand and to increase the smoothness of the production process. However, numerous innovations probably could not stand on their own when subjected to a rigorous rate of return analysis. For example, intra-airport transit systems and terminal building designs may be reevaluated with more thorough scrutinization of the contribution made by each component of the system. For example, does an airport people-mover system increase demand for air travel or decrease the cost of air travel sufficiently to offset the system's investment? In the past, this sort of question has not been asked, but airlines will increasingly make such inquiries in the future, because on the margin, the airline will bear the incremental expenditure in airport facilities. In summary, the technology of the future will be less exotic, it will be more oriented toward labor-saving innovations on the landside.

Closely related to these trends is the likelihood that service levels also will reflect this trend away from the exotic and toward the cost effective. "No frills" services may become a channel through which the older less revolutionary technologies will be utilized to provide lower cost air services to patrons not interested in the quickest most convenient service package.

AMTRAK

The future for AMTRAK is not expected to parallel that of the airlines because the rail passenger carrier receives virtually all of its direct funding from the public sector. As is thoroughly documented in one of this report's issue papers, "Financial Issues Impacting Intercity Transportation," the investment criteria employed by the government are entirely different from private sector goals and results. The public

sector position as financier of AMTRAK is chiefly explained by past trends in costs and revenues which had no prospect for self-sustaining services (i.e., revenues exceed long-run marginal costs).

However, similar to the airlines, the public sector role in intercity rail passenger transport is deemed a worthwhile allocation of public funds, because AMTRAK provides a service with important benefits accruing to nonusers. Its long-haul services are justified because of the need for common-carrier transport to cities which do not receive air service. Furthermore, there are substantial political pressures to continue these services in spite of massive operating deficits.

Northeast Corridor services consist of an entirely different set of social costs and benefits. Here, the density of rail travel is projected to increase rapidly in terms of both absolute passenger-miles and market shares. This increase will come about as a result of a federal policy commitment to upgrade the frequency, speed, reliability, and comfort of rail travel in the Boston-Washington corridor. Furthermore, the federal government perceives that a multibillion dollar investment in rail is preferable to alternative investments in interstate highways or short-haul air transport. Thus, profitability is not a prerequisite to investment in AMTRAK. Rather, the overall social costs and benefits associated with AMTRAK services has led the federal government to authorize funds for upgrading this service.

The principal purpose for use of the federal funds will be to finance new rounds of equipment during the next 50 years. Presently, AMTRAK is in the process of purchasing a new fleet of "Amcoaches" for use in both long-haul and Northeast Corridor markets. However, management is looking further into the future at French and British prototypes of equipment technologies such as British Rail's Advanced Passenger Train. AMTRAK's principal direction of investment policy will be in high-performance equipment; however, some investment will be channeled toward modernized facilities for maintaining the equipment. Furthermore, AMTRAK has been rapidly moving toward parity with the airlines in ticketing, passenger information systems, and reservations. In order to improve the quality of service, AMTRAK may also begin to consider innovating in the traditional method of station design and baggage handling.

Probably the biggest area of controversy during the next 50 years will be in the context of maintenance and control over the right-of-way. Already, AMTRAK is moving toward the takeover of the Penn Central Transportation Company's main line from Washington to Boston. AMTRAK feels that absolute control over this infrastructure is needed to implement a total program of upgraded service. However, in corridors in which passenger operations are basically a secondary user of the right-of-way, AMTRAK will be continually conflicting with the freight operators. The conflicts will be over operating speed limits, slow orders, delays, and ride characteristics. The freight railroads do not have any profit-oriented reason to maintain the roadbed at a level commensurate with the goals of AMTRAK. Therefore, the conflict will be over AMTRAK's aspiration

for high-speed, high-quality service versus the freight operator's desire to extract the most cost-effective movement of ton-miles over the roadbed.

There are several resolves to this conflict. One is the potential nationalization of the freight rail system which could come about as a result of the inability of the freight railroads to revitalize their presently poor financial footing. Another resolve could come about through a renegotiation of the user charges paid by AMTRAK for operating the train over the freight railroad's tracks. Third, AMTRAK could channel funds into the development of new equipment technologies which would not require as high standards of roadbed conditions to permit high-speed operations. The fourth possible solution to the conflict would be AMTRAK acquiescence in its goals for high-speed services; this withdrawal could come about in the form of low-speed or discontinued services.

Aside from the conflicts over joint freight-passenger use of right-of-way, the principal issues of financing rail passenger services relate to the public sector's recognition that passenger service is, in fact, in the public interest. To the extent that this determination is made, funds will be available for equipment, infrastructure, information systems, maintenance, and terminals.

There are some interesting implications that are likely to emerge from these trends in AMTRAK's future. Long-haul passenger services could very easily be discontinued if the battle with the freight carriers cannot be resolved at a level requiring a reasonable expenditure of federal funds. Eventually, the mood of Congress may turn against rail passenger services and may permit the long-haul trains to be abandoned as they almost were before the establishment of the AMTRAK legislation.

However, if AMTRAK, with congressional backing, decides to strive in earnest to revitalize long-haul passenger services, then extensive research into technologies of long-haul passenger trains may be conducted. AMTRAK may experiment with new generations of auto-train-type equipment and services, American versions of overnight European trains, and demand-stimulating innovations designed to differentiate rail from competing modes. In summary, the possibility of research into innovations in long-haul technologies will be almost purely a function of AMTRAK's commitment to the future of long-haul trains.

With respect to the Northeast Corridor, AMTRAK has already demonstrated its financial commitment to improvement of this facility. However, the levels of service will be closely tied to the quantity of funds committed for improvement of the infrastructure. In the long run, Amtrak may search for innovations in equipment so that high-speed services can be introduced without expensive investment in roadbed.

In summary, the future of intercity passenger technology, service qualities, and market share will be inextricably bound up in the seriousness of the federal commitment to fund AMTRAK.

IX. ISSUES IN REGULATION OF INTERCITY TRANSPORTATION

by

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ABSTRACT

Naturally, monopolistic industries (public utilities, some transportation, common carrier communications) require economic regulation to ensure output increases toward socially optimum levels. The most common regulation is an established maximum rate of return on capital.

Regulation tends to be legalistically precedent-oriented and backward-looking when unprecedented economic and technological changes occur. Transportation regulation is often regarded as oppressive, complex, and all-pervasive and pressures are developing for "deregulation" or "regulatory reform."

Regulation has helped in the development and control of transportation infrastructure and in the operation and organization of transportation firms. It inhibits or spurs market entry and exit, technological innovation, program implementation speeds, and financial viability of transport systems.

Three general dimensions of regulation are "coverage," "specificity," and "locus."

The degree of regulation coverage varies both between and within transport modes, but the trend is toward broader coverage. Control of entry/exit, one of the strongest mechanisms to manipulate transportation markets, is crucial to the emergence of new intercity transportation (ICT) modes and carriers. The Civil Aeronautics Board (CAB) and, to a lesser extent, the Interstate Commerce Commission (ICC) appear willing to permit cessation of service to unprofitable markets.

The ICC is permitting railroads to own other modes: air freight, barges, trucking, and pipelines. Horizontal integration across modes permits cross-subsidization and smooths cyclical fluctuations. Over the next 25 years, ICT industry control will be concentrated in fewer companies. Railroads will own inland waterway operators, and airlines will own and operate truck lines.

Many transportation companies resemble well-diversified holding companies because of vertical integration and conglomeration. Railroads have been sharply criticized for "disinvesting" in the transportation industry. More stringent regulation of entry/exit and financial constraints may result in firms locked into low rates of return, unable to attract adequate private capital, and ultimately caught in the downward spiral towards nationalization.

Reformers advocate more generalized, nonspecific regulation to reduce regulatory interference with day-to-day management decisions; CAB and ICC regulatory staffs, however, are pushing for more specific regulations.

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The economic and social costs and benefits of specific regulatory practices should be included in an evaluation of regulations.

Transport regulations flowing from consumer legislation (environmental protection, public safety, health) are often unenforceable because of lack of budgetary or technical means of monitoring; these regulations will either be consolidated, adequately funded, or allowed to lapse.

The current locus of transportation regulation is the layered decentralized system. The tremendous overlap of authority existing both between and within different levels of government produces layers of redundant and conflicting regulations. Strong pressures within the federal government exist for greater centralization of authority, which might lead to insensitivity to local problems; conversely, a powerful force opposing centralization is the widespread mistrust of bigness in institutions, which may contribute to a continuation of the present fragmented system.

Over the next 25 to 50 years, more than one swing back-and-forth between a centralized locus and a decentralized one is possible, depending on the number of economic recessions and booms.

Fragmented, decentralized authority, although providing maximum exposure of issues (economic, social, safety, etc.), allows special interest groups to utilize the numerous appeal and review mechanisms to generate "regulatory lag." A centralized locus would shorten the appeal process, reduce lag, and facilitate technological innovations, although perhaps restricting exposure of some issues. Current trends portend expanded appellate mechanisms, but a swing in the other direction may follow a change in the political/social/economic climate.

The ICC has been accused of stifling innovation and preserving the status quo; the CAB is regarded as a promoter of new technologies. A multimodal regulator may be better suited to the needs of a large consumer or geographic constituency; a collection of single mode regulators might generate greater intermodal interface problems.

Useless transport industry accounting systems upon which regulators must rely should be replaced with a uniform accounting system that follows generally accepted accounting principles and provides performance data for cross-modal comparisons.

The abhorred concept of nationalization would simplify the regulatory process through centralized implementation of objectives and removal of overlap and layering. By 1990 to 1995, transport bankruptcies will engender either nationalized or quasi-nationalized freight transportation, and nationalized and private companies will compete for the same markets. Purely private enterprise solutions are reliable only for the short run. Rapidity of nationalization hinges on federal initiatives, interim successes, and a favorable political/economic climate.

Taxation, a powerful policy tool, should be used more vigorously as an alternative to nationalization by creating progressive/regressive subsidies to aid/hinder development of different modes.

Regulatory policies here and abroad affect availability of foreign technology for the transportation industry. As regulations approach global uniformity, technology transfers between nations will increase.

It is unlikely that any revolutionary regulation approach will materialize soon. Reform will be shaped by the cyclical swings of the economy. Reversals will affect the trade-offs between competition and economies of scale.

IX. ISSUES IN REGULATION OF INTERCITY TRANSPORTATION

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IX. ISSUES IN REGULATION OF INTERCITY TRANSPORTATION

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Introduction

Control of the marketplace by government regulation through laws, taxation, and incentives has been a fact of economic life for many years. Inscriptions on clay tell of King Urkagina, of Lagash on the banks of the Euphrates, who set forth prices and wages for goods and services around 2425 B.C. A thousand years later, the rulers of Babylon were fixing interest rates, requiring contracts, and trying civil cases of economic disputes. In 301 A.D., the Emperor Diocletian issued his *Edict on Price*. The *Edict* set wages and prices to be paid for the production of commodities and required that producers sell certain minimum amounts of food, hardware, and fuel to the cities of the Roman Empire. Penalties for not complying with the *Edict* included castration, crucifixion, and slavery.

While governments have always manifested a disposition to impose controls on the governed, the need for explicit economic regulation is attributable to the naturally monopolistic character of certain industries. That is, a natural monopoly exists when there are such economies of scale in the production of goods or services that the existence of additional competing enterprises would considerably increase the cost to the society within a geographic area. Cost curves of natural monopolies are downward-sloping, which means that an unregulated private enterprise manager will seek to restrict production in order to reap monopolistic profits. However, since private and social average costs decline with increased output, the regulator's objective is to ensure that industry output is increased toward the level of the social optimum. Natural monopoly characteristics prevail in the public utility, transportation and common carrier communications industries. When such industries are not under public or government ownership, regulation is required to prevent the monopoly from producing too few units of output and charging excessive prices. Regulation protects the monopoly, but it imposes a set of regulatory constraints. The most common constraint is an extablished maximum rate of return on invested capital. This and other characteristics of economic regulation are the subject of this paper.

In addition to economic regulation of specific industries, there has accrued an additional and increasing body of regulation and government controls, generally not industry-specific, but instituted to protect public health and safety or otherwise protect the consuming public. Since regulation is legislatively mandated and has the force of law, its implementation and exercise have been couched in legal terms. Regulatory commissions have been predominantly staffed by lawyers, and commission deliberations and rule-makings have generally been adversary proceedings with great attention paid to due process, procedural matters,

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rules of evidence, and burdens of proof. With this orientation, the exercise of regulation tends to be precedent-oriented and backward-looking even in the face of unprecedented changes in economic institutions and technological developments. Established regulatory bodies are viewed as inhibitors of change rather than promoters of change; they are more rigid than flexible.

The magnitude and scope of regulation of the marketplace has waxed and waned over the years. Today we are faced with the apparent paradox of regulation being regarded in some circles as so oppressive, complex, and all-pervasive that additional regulations are required to provide some degree of freedom from regulation. This is especially true in the transportation industries which seem to suffer from an abundance of regulations, imposed from a variety of directions and embodying varying degrees of enforceability and rationality. Current government pressures exist for "deregulation" and "regulatory reform" within the transportation sector. At the same time, in other sectors of the same government, regulations are being enacted to ensure that the transportation industries will increase their safety standards and decrease pollution. In the process, the government hopes not to undermine fatally the financial position of the industries' owners.

Regulation has played, and will continue to play, an important role in both the development and control of transportation infrastructure and in the operation and organization of firms providing transportation services in the United States and neighboring countries. Regulation can act as a barrier or a spur to such important factors as: market entry and exit, technological innovation, speed of implementation of programs, and financial viability of transportation systems.

Briefly, some of the forces for change that are discernible, over and above the need for continuing surveillance to prevent abuses of economic power (actual and potential) and ensure the "safe-guarding of the public interest," are:

- Concern about inflation and the inflationary impact of much governmental regulation.*
- Concern about recession and the perceived need to change or relax regulatory constraints as an economic stimulant.
- The cumulative effects of environmental externalities, e.g., air and water pollution, and the need to supplement or correct for inadequate marketplace incentives.

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*M. L. Weidenbaum, *Government Mandated Prices Increases, A Neglected Aspect of Inflation* (Washington, D.C., American Enterprise Institute for Public Policy Research, 1975).

- Actual or imminent financial collapse of major firms in regulated industries.

- Change in the transportation mix, due either to changes in demand or technological innovations,* which create a need for some form of regulatory accommodation.

- Changes in social values, perceptions, and mores which either call for or provide support for legislative initiatives, new interpretations of regulatory mandates, and extensions or reevaluations of governmental interventions in private sector enterprises.**

- The mere accretion over time of the regulatory *corpus dicta* (rules, codes, standards, administrative practices and procedures, legalisms, vested interests, protectionisms, subsidies, cross-subsidies, rates, tariffs, conflicts, exceptions, and miscellaneous paraphernalia and accoutrements) leads inevitably to periodic need for housecleaning, rationalization, and an unfettering of regulated firms from the accumulated overburden.

- The propensity of firms under economic regulation to use their protected monopoly position to invoke regulatory procedures, to control information, and to otherwise act in such as way as to preempt or discourage competition tends to create a need for continuing adaptive regulatory response, particularly within the adversary relationship of government and industry.

- Given the propensity of government to invoke rationing to meet scarcity and an impending shortfall in capital resources, there may be efforts to ration capital or control investments in various sectors through selective incentives and disincentives.

This paper assesses the current regulatory "climate" in the United States, particularly as related to intercity transportation. It also presents an interpretation of the future of significant regulatory issues and their probable impacts on intercity transportation over the next 25 and 50 years.

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*A. J. Gellman, "Surface Freight Transportation," *Technological Change in Regulated Industries*, edited by W. C. Capron (Washington, D.C.: Brookings Institution, 1971).

**See the companion issue paper on "Social Impacts on Intercity Transportation."

Relevant Issues

The format of this paper is an issue-by-issue treatment of relevant regulatory issues and their impact on intercity transportation. Where appropriate, the relationship between different specific issues will be discussed. Three general dimensions of regulation can be defined heuristically to focus discussion: "coverage," "specificity," and "locus." Specific issues within each of these categories are discussed individually; those issues which do not fit into a specific category or which overlap two or more categories are treated separately.

Coverage of Regulation. By "coverage" is meant the extent to which a given regulation or regulatory scheme applies to the commodities to be transported and the modes for their transportation. On one extreme of the coverage spectrum would be regulation which encompasses all modes; on the other extreme would be regulations which relate to a specific commodity in a specific transportation mode. A regulation which requires that all transportation companies must file a certain type of tax return represents a broad coverage regulation. The Interstate Commerce Commission regulation of grain rates in unit trains represents a narrow regulation.

Currently, the degree of coverage of regulation varies substantially from mode to mode and within individual modes and commodities. For example, grain rates are regulated in rail transport but not usually regulated in motor carrier or water transport.

The general thrust in regulatory coverage in recent years has been toward broader coverage, particularly the recent movement toward, and discussion of, "reregulation" of the surface modes. This movement has as one of its premises a "zone of reasonableness" approach to rate-making which would allow the carriers to adjust rates within specified ranges rather than use the single rate as currently in effect.

Entry/Exit. Regulations exist to prevent destructive competition and gain the cost advantages possible through economies of scale and natural monopolies. Currently, control of entry/exit is one of the strongest mechanisms used by regulatory authorities to manipulate transportation markets. Although the exercise of this regulatory authority varies by mode, commodity, and location (and the authority may be federal, state, or local), the control over entry/exit in the transportation sector is all-pervasive. (See Table IX-1.) There does not appear, over the short run, to be any relaxation in this form of regulation; in fact, if government funding becomes a more important part in the financing of transportation systems, this control mechanism will be strengthened.

In the case of large-scale intercity transportation investment, it is unlikely that significant numbers of new modes or carriers could

Table IX-1

REGULATION OF INTERSTATE DOMESTIC SURFACE CARRIERS BY TYPE AND MODE
1970

Type of Regulation	Modes			
	Rail	Highway	Water	Pipeline
Rates	Full	Partial[a]	Partial[b]	Partial[c]
Entry or exit through carrier expansion or contraction	Full	Full	Full	None
Entry through merger or acquisition, same mode	Full	Full	Full	None
Entry through merger or acquisition, other mode	Partial	None[d]	None[d]	None[d]
Overall quantity of service	None	None	None	None
Quality of service, including route	None	Full	None	None
Limitations on commodity and direction-of-traffic	None	Full	None	None

a. The degree of rate regulation is largely a function of the form of of carrier organization. Common carrier rates are regulated the most; agriculturally exempt and "private" carrier rates (or internal prices) are not regulated. Contract carriers fall in between.
b. This is similar to highway regulation, except that exemptions are granted for other reasons besides the agricultural commodities provision.
c. Rates are regulated on a rate-of-return basis; hence, individual rates are the object of very little regulatory concern.
d. There is no explicit prohibition. Entry is subject to ultimate interpretation by the Interstate Commerce Commission and the courts.

Source: A. J. Gellman, "Surface Freight Transportation," *Technological Change in Regulated Industries*, edited by W. C. Capron (Washington, D.C.: Brookings Institution, 1971).

emerge *without* some form of government funding, particularly for the construction of infrastructure, and *without* some form of government control over entry/exit. There appears to be an increasing willingness of the Civil Aeronautics Board and, to a lesser degree, the ICC to permit cessation of service to unprofitable markets, and disregard anything other than strong opposition from the communities affected. The cessation of air carrier service is very much simpler than rail abandonments.

Industry Integration and Diversification. There are two forms of integration in the transportation industry:

1. Horizontal Integration--When carriers expand markets by acquisition of competition in the same mode, or when more than one mode comes under a single ownership, e.g., an airline, a railroad, and a trucking company.

2. Vertical Integration--Whereby a carrier acquires control of its suppliers or customers, or a nontransportation firm acquires control of a carrier, e.g., a railroad owning a railroad brake equipment manufacturer or a steel company owning a railroad.

While both horizontal and vertical integration are normally part of a firm's interest in diversification, they have more direct competitive implications than the case of a transport carrier diversifying into nonrelated industries, i.e., forming a conglomerate enterprise. There are, however, important public policy implications associated with a transportation firm's investing in nontransport-related industries when such investment threatens the financial viability of the transportation company. Conflomerate diversification will be discussed under vertical integration.

Horizontal Integration. Historically, the ownership of carriers in different modes by a single operating company brought on many abuses which resulted in the current restrictive regulations. Railroads were particularly notorious in acquiring water carriers and using their monopoly power to force business off the water and onto the rails.

The ownership of multimodal carriers by a single controlling entity is currently being acknowledged *de facto* if not *de jure*. The ICC has permitted railroads to acquire air freight forwarding companies, barge lines, and trucking subsidiaries (through the guise of piggyback). Pipeline companies are also owned by railroads. No corporate entity has yet been able to assume a major role in more than one mode, and it is probably unlikely over the short term that this will happen. However, some of the joint-ownership concepts, under consideration as part of the currently proposed "deregulation" legislation, would permit the creation of transportation holding companies which could evolve into fully integrated (full-service) transportation companies. The potential economic and

service benefits of joint ownership have to be weighed against the potential for abuse which would be possible under such ownership. Horizontal integration across modes offers the carrier an opportunity for cross-subsidization of modes in order to smooth the cyclical fluctuations of traffic. The concept of cross-subsidization within a given mode (particularly railroads) is widely accepted in current regulatory philosophy and practice. Railroads carrying certain articles of freight at or below marginal cost in certain markets in exchange for the privilege of hauling other freight at relatively high profit is a well-established part of railroad regulatory history. The rationale is that overall viability of the transport firm is strengthened if it is allowed to use "value of service" pricing of its product. Conceivably, cross-subsidization could be extended to allow intermodal expansion by various carriers.

If present regulatory trends continue, it would appear that control of the transportation industry will be concentrated in increasingly fewer companies. It is unlikely that in 15 to 25 years there will be significant railroad ownership of air carriers or vice versa; however, it can be expected that railroads will own inland waterway operators and that airlines will own and operate truck lines.

Vertical Integration and Conglomerates. The concept of transportation companies owning their own suppliers and/or customers has existed for a long time. Traditionally, railroads have supplied internally many of their own cars and locomotives. Yet, railroads have been consolidated into even bigger vertically integrated enterprises, as well; for example, the Ford Motor Company acquired the Detroit, Toledo and Ironton Railroad. Ford even ventured into aircraft manufacturing and civilian aviation.

While the Interstate Commerce Act effectively broke up large transportation holding companies, many of today's transportation companies closely resemble a well-diversified holding company. This subject has become increasingly controversial particularly in the railroad industry where diversification is blamed, at least in part, for the demise of the Penn Central. Railroads have been sharply criticized for "disinvesting" in the transportation industry; i.e., they have channeled investable cash flows from railroad operations into nonrail-related investments such as real estate, oil wells, pipelines, coal mines, etc. Defending these diversifications, executives state their primary obligation is to earn maximum return for stockholders, and if diversifying into transportation activities stabilizes income and produces higher profits, then these investments are justified. The opposing argument is that "disinvestment" is contrary to the public interest because it weakens the viability of essential transportation services. It is not unlikely, therefore, that regulation of the types of investments which transportation companies can make, particularly in nontransportation industries, will be added to the specific powers of the government.

Such regulation would further tighten the entry/exit and financial constraints on the transportation industry. It could lead to the creation of transportation companies locked into low rates of return, unable to attract adequate capital from private-sector investors, and ultimately caught in the downward spiral toward nationalization. This spiral was visible in the 1950s and 1960s when the railroads could not earn profits from passenger services. Therefore, without any aid forthcoming, they assiduously sought to withdraw all passenger-related investments. They provided the bare minimum of acceptable services. By 1971, intercity passenger services were nationalized via the Amtrak mechanism. Most railroads have been unable to raise new equity or long-term debt capital for several decades. Investment in fixed plant has been appallingly low. The claim of management is that under current conditions, it is impossible to commit long-term funds to investment projects having such low profit prospects.

This same spiral exists elsewhere in transport. The airlines may be in an early stage of decline. The industry as a whole--not just the weak companies--has encountered discernible resistance to new financings. Uncertainties of fuel prices, regulatory policy, and traffic growth have scared investors away from the industry. Certainly, one of the regulatory issues in the future will be constraint upon the regulators to keep the industry profitable enough so that it can raise investment capital.

Specificity of Regulation. "Specificity" means the degree to which regulation is applied to the direct operating parameters of the regulated entity. A relatively nonspecific form of regulation is represented by rate-of-return regulation. A regulation which dictates the amount of tire wear for a tractor trailer to be legally operated on the highway is highly specific. The types of regulations usually brought to bear by the arms of government, which are "normally" the relevant economic regulating agencies, are relatively nonspecific. The ICC's regulation of pipeline involves simple rate-of-return regulation. Its regulation of railroads, trucks, and buses is basically rate-oriented. Approvals by the CAB or ICC of across-the-board rate increases represent a highly generalized form of control.

It is important to note that many regulations imposed on transportation industries are from agencies which are not *specifically charged with regulation of these industries*. Nonindustry-specific regulations tend to be highly detailed. The source of these regulations is often an agency which is charged with general responsibility in another area such as the Environmental Protection Agency, the National Transportation Safety Board, or the Occupational Safety and Health Admonistration (OSHA). Currently, these "fringe" agencies have broad powers to enforce compliance on the part of regulated firms as part of their general mandate. In the short term, pressures for reform will undoubtedly establish new regulators with fringe powers. However, as the impact of the fringe regulations is more strongly felt, counter pressure will accumulate for establishment of a centralized regulatory authority. At the very least, rationalization of conflicting regulations and their economic impact is required.

A serious short-term consequence of this trend to a multiplicity of fringe regulations is that the proliferation of overlapping and conflicting regulations will make it extremely difficult to nucleate large scale developments of new or novel systems or programs in a regulated industry. The various special interest groups will have such power (because of the variety of regulatory mandates and appeal mechanisms to be complied with) that "regulatory lag"* will grow to untenable proportions. There are several examples of the impact of regulatory lag as a retardant of technological innovation. A good case in point is the long delay in the introduction of the Southern Railroad's "Big John" hopper cars.**

Advocates of regulatory reform support more generalized and nonspecific regulation because they feel that regulatory authorities are unnecessarily interfering in the sphere of day-to-day management decisions. In contrast, the "internal" thrust within the regulatory commissions is generally in the opposite direction. An examination of a staff study by the CAB's Bureau of Operating Rights indicates that its internal thinking is toward more specific control. In their report: "The Domestic Route System: Analysis and Policy Recommendations,"*** the thrust of the discussion is that the CAB will expand its authority over the regulated airlines by enforcing standards of acceptable qualities and quantities of service in specific city-pair markets.

The CAB plans to monitor a carrier's performance in specific city-pairs, and it plans to intercede in those markets in which the quality of service is deemed unacceptable. The CAB prefers to use this power to encourage the airlines to "rationalize" their route systems by withdrawing from the markets which are not profitable. This policy reflects the belief that specific regulation of individual market situations can improve the industry's economic well-being better than generalized regulation.

A not unexpected characteristic of this proposed extension of regulatory control by the CAB is the apparent preoccupation with procedural matters. For example, the report allocates 25 pages to describe "Regulatory Policies for the Future"; more than half of that effort is devoted to a description of the legal procedures for implementing the policy. Economics, on the other hand, receives only minimal treatment within the 25 pages.

The ICC made remarks similar to those of the CAB staff. ICC's general counsel, Fritz Kahn, has lashed out at shipper- and US DOT-supported

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*By "regulatory lag" is meant the time which is lost between the conception or proposal of a program and its implementation due to the necessity for compliance with regulations and regulatory procedures.

**See for example, A. J. Gellman, op. cit.

***U.S. Civil Aeronautics Board, *Regulatory Policies for the Future* (Bureau of Operating Rights Staff Study), October 1974.

efforts to lessen the Commission's zone of influence. *Railway Age** characterized Kahn as calling "for more rather than less regulation." Kahn's and CAB's remarks are diametrically opposed to popular and Congressional attitudes. Transportation improvement bills before Congress clearly indicate that a move toward less regulation is under serious consideration.

In contrast with the regulatory commissions, DOT's stance on most problems is relatively nonspecific. DOT's apparent objective is to ensure viable service from optimally sized firms serving a competitive marketplace. Secretary Coleman's expressed opinion on rail industry structure is that the industry would be more viable if concentrated into a small number of large, efficient transcontinental carriers. The approach of DOT is to catalyze mergers which would bring about industry rationalization.

Cost/Benefits of Regulation. Important factors which should be included in any evaluation of a regulation are the costs and benefits attributable to the specific regulatory practice. The costs of regulation can be measured as the sum of the expenditures (both economic and social) associated with maintaining, policing, enforcing, and monitoring the regulation, which should include the additional costs imposed on the regulated firms and their customers for compliance. The benefits of regulation may be reduced costs, improved service, greater safety, and greater reliability and/or protection from the monopoly power inherent in the industries which are regulated.

Presently, no formal cost/benefit accounting exists in the regulatory process. In fact, few attempts are made to measure the direct or indirect costs required by a given regulation. As the socioeconomic planning tools become increasingly accurate, the regulators will have more reason to rely upon them.

Unenforceable Regulation. Most legislation generally identified with the consumer movement in the United States (concerning environmental protection, public safety, health, equal opportunity, *inter alia*) impinges upon the transportation industry in what were described previously as "fringe" or nonindustry-specific regulations. Some of this fringe legislation and regulation falls into an unenforceable category since the budgetary or technical means for its enforcement are not available. It is virtually impossible, for example, or at least very costly, to ascertain at all times whether a diesel locomotive pulling a train exceeds the federal emission standard. Assuming the

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**Railway Age*, June 9, 1975.

consumer movement retains its momentum, the expectation is that these fringe regulations will either be consolidated into a package of enforceable regulations coupled with the necessary financial and staff support to ensure enforcement, or be allowed to lapse or continue unenforced. To aid in enforcement one can also imagine vigilante-type "inspectors" and "enforcers."

Locus of Control. The "locus" of a regulation refers to the sources from which regulatory authority emanates and is implemented. On one extreme is decentralized regulatory authority in which federal, state, regional, and local institutions each wield some influence over transportation. In contrast to this layering of authority is a hypothetical centralized regulatory agency which is a singular central repository of authority over all modes and all situations.* In addition, authority may be centralized or fragmented within a level of government. The current locus of regulation most closely resembles the layered decentralized system.

Overlap/Layering. Currently, for all modes of transportation a tremendous amount of regulatory authorities exist between, and within, different levels of government. Ideally, each regulatory agency should not impinge upon another; the regulations of each institution should complement the other. However, overlapping responsibilities usually produce layers of regulation which are redundant or conflicting. Thus, layerings are the causes of inconsistencies, unnecessary duplications, and regulations which are mutually unenforceable. It is not unusual for different government programs, each directed toward maximizing a specific objective, to result in situations in which the goals of one are in conflict with the other. A current example is the conflict between the Environmental Protection Agency's (EPA) efforts to reduce motor vehicle emissions and the Federal Energy Administration's (FEA) techniques to reduce motor vehicle fuel consumption. In such situations, re-evaluation of national priorities is forced, resulting in pressures in opposite directions to relax, suspend, defer, or otherwise ameliorate the regulations of one to the benefit of another.

With respect to intergovernmental layering, strong pressures for greater centralization of regulatory authority within the federal government will continue at least in the short run. Centralization can lead to a lack of sensitivity to local problems. This is reflected, for example, in the

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*For example, as envisioned by U.S. Senate bill S. 1770, "The Rail Revitalization and Energy Conservation Act of 1975," introduced by Senator McGovern, *Congressional Record*, S8571-S8584, May 19, 1975.

USRA's* alleged general neglect of the views of many state and local governments in preparing its Final System Plan for the reorganization of the Northeast railroads under the Regional Rail Reorganization Act of 1973.

Presently, a powerful force opposing centralization is the widespread mistrust of bigness--"big business," "big labor," and big government"--in many institutions. This sentiment may be partially responsible for a movement away from further centralization of regulatory authority within the federal government. One result of this movement may be a further continuation of today's fragmented regulatory authority. Alternatively, these dispersed groups might be supervised and controlled by a centralized policy-making group designed to ensure that national goals are met while granting broad leeway for regional and local applications of policy.

It is virtually impossible to predict at this time how far the pendulum of centralization might swing. In a 25-year and 50-year span, more than one swing from a centralized locus of regulatory authority to a decentralized one and back again could be encountered. The degree to which such swings occur will probably be dependent on the number of times a recessionary economy is encountered. As previously discussed, the propensity to change the thrust of regulatory direction is usually heightened by downturns in economic vitality.

Appeals. The process of appeal and review has become a principal characteristic of the machinery of the regulatory process. Fragmented regulatory authority creates a wide variety of opportunities to impede the process through appeals and reversals. Decentralization multiplies the appeals process which may possibly produce maximum exposure of all issues--economic, social environmental, safety, etc.--before a wide variety of regulatory bodies. Unfortunately, this method of broad exposure of issues leads to long delays in, or outright denial of, the implementation of any given project. Indeed, cumbersome regulatory hurdles do function as a barrier to introduction of changes in regulated industries.

A centralized regulatory locus will tend to have a narrower arena of appeals which usually at least shortens the time span of the appeal process, resulting in a lowering of the barriers to technological innovation due to regulatory lag. Of course, such a process may have the disbenefit of restricting exposure of some issues.

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*This case is significant in another respect, since the United States Railway Association has become the *de facto* regulator in the Northeast rail situation, even though it does not hold general rail regulatory authority.

Current trends portend additional steps in appeal mechanisms above current practices. As the process *per se* increasingly becomes the cause of regulatory ineffectiveness, a reaction will undoubtedly occur leading back toward a more centralized, and possibly more restrictive appeal process. Approaches which could aid the implementation of large scale or technologically innovative programs are shifting the burden of proof to the protestants to the proposed changes, and allowing implementation to occur unless specifically disallowed.

The course of the appeal process will depend to a large extent upon the political/social climate in the country. Under conditions of high social and environmental consciousness, a much more time consuming and broad-based appeal process may be likely. Under conditions favoring monopoly power, big business, or strong centralized federal government, the appeal process may tend to be shortened and considerably less open.

Impact of Regulatory Locus on Innovation. The concept of an ultimate evolution toward a centralized regulatory locus was introduced above. Conceptually, this sort of locus should regulate all modes objectively, but it may not be well suited to the development and introduction of innovative technologies and marketing techniques.

To understand this problem, one must examine the behavior of regulatory agencies today. Regulators have the ability to create a climate conducive to the promotion of the process of innovation. The Interstate Commerce Commission has been accused in many circles of being a significant barrier to innovation. In contrast, the Civil Aeronautics Board is generally regarded (with some exceptions) as a promoter of technological developments in the airline industry. Note that the ICC has responsibility for regulating four modes of transportation, while the CAB regulates only one. Possibly, the ICC's difficulty arises because it must not unfairly regulate one mode to the detriment of another. Therefore, it is convenient for the ICC to look toward preserving the *status quo*. The CAB, on the other hand, is statutorily mandated to promote commercial air transport.

A large, single, centralized planning locus may compound the problem of thwarting creative technologies and ideas which only better a single mode. However, if the constituency of the regulatory agency was largely consumer- or geographic-oriented, then the notion of "fairness" might focus upon overall quality and quantity of all services rather than the health of any one mode or company. In addition, a separate, individual agency mandated to regulate and *to promote* a single mode might very likely aggravate a problem that has always plagued this industry--the modal interface problem. If each mode was encouraged to maximize its own internal utility function, the net effect might be a worsening of interface bottlenecks and a reduction in the efficiency of the overall transport system.

Other Regulatory Issues. Presented below are several issues not explicitly covered in prior discussions and which do not readily fit into the coverage, specificity, or locus categories.

Accounting Systems. Economic regulators must rely upon the regulated firm to provide information measuring financial, operating and service conditions, and performance. This information is vital to the effectiveness of the regulators. The extent to which the information system depicts actual economic performance obviously directly determines its worth as a tool of the regulators. In addition, the accuracy of information influences the precision and effectiveness of regulations.

Unfortunately, accounting systems are one of the great weaknesses of the regulatory agencies. Often these systems rely upon anachronistic principles which result in figures which are virtually meaningless as decision-making guides. Because regulators, like the ICC, rely upon unrealistic accounting systems, managers of transport companies are forced to make decisions distorted by this added constraint.

In the future, the transportation industry needs a uniform system of accounting which conforms to generally accepted accounting principles and which provides performance data for cross modal comparisons.

Regulatory Constraints versus Economic Conditions. The propensity of society as a whole to demand changes in the regulatory process appears to be influenced substantially by the economic climate of the times. When economic conditions in the country are stable or growing, there is less pressure for revision of regulatory institutions than in poor economic times. As economic conditions worsen, society generally feels that government has to do something in order to assist in turning economic conditions around. One manifestation of this phenomenon is the demand to change the direction of the regulatory process. To a certain degree, this is currently being reflected in the pressures for deregulation and reregulation for certain sectors of the transportation industry.

Regulatory Lag. There are two types of regulatory lag which are important from the transportation industry's point of view. The first is the delay caused by the regulatory process itself. As greater layering and overlapping occur in the regulatory process, lag increases. A greater centralization of the locus of regulatory authority will probably contribute to a decreasing of regulatory lag. The near-term outlook is for a gradually increasing lag time, due to the movement toward decentralization and the layering and overlapping of the regulatory authorities. This trend is expected to continue until the moves toward centralization of regulatory authority and reform efforts gradually reduce the lag time.

The second type of regulatory lag is the reaction time of the regulators in response to technology. In such a case, there is a lag between the initiation of a new technology and the determination by the regulators that they should formulate a policy in response to it. The uncertainty involved in lags of this type may constitute a substantial barrier to a firm's willingness to invest in the development or introduction of a technology.

Nationalization. The concept of nationalization (i.e., government ownership of one or more modes of transportation) has been regarded as abhorent by every administration since that of George Washington. Simple mention of the term seems to galvanize the free-enterprise-oriented segments of the nation. The term is frequently used with reference to the railroad industry, although it has been mentioned concerning airlines and water transportation companies. From the standpoint of regulation, nationalization would actually represent a vast simplification of the regulatory process because a nationalized transportation company has as part of its charter an implicit set of government-controlled objectives to govern its operations. Outright ownership would obviate much of the overlap and layering which exists within the current regulatory framework.

Notwithstanding popular opposition to socialism, the expectation is that by 1990-1995 bankruptcies of some transportation companies will force an enlarged government involvement in transportation to the extent that either a nationalized or quasi-nationalized freight transportation and passenger transportation system will have evolved.* It is likely that nationalized companies will compete with private ones for the same market, although making some investments that private enterprise would not make. A format for such competition might be that which currently exists in Canada, where the Canadian National and Canadian Pacific Railroads compete. Differences in the geographies of the two countries probably preclude an exact duplication of the Canadian concept within the U.S.

Before outright nationalization occurs, several interim solutions to the bankruptcy problem will probably be tried first. However, in the long run none of the solutions designed to rely upon private enterprise will meet the national transportation needs. Conceivably, in 25 years the rail infrastructure may still be in one of the interim steps between private enterprise and nationalization. For example, national ownership of rail rights-of-way could represent an interim solution lasting 20 to 30 years. The rapidity with which nationalization comes about will depend in large measure upon the federal government's

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*Of course, public ownership of transportation systems at the local/urban level is widespread (even when operated under contract by a private firm), and public ownership of transportation infrastructure is similarly widespread, excepting obviously the railroads.

perception of its mandate, the success or failure of certain intermediate events,* and the political/economic environment existing in the country during the intervening period.

Role of Taxation. As an alternative to nationalization, the federal government may use taxation as a form of progressive or regressive subsidy to aid or hinder the development of given modal choices. Tax incentives represent a powerful tool of public policy. Tax can be used to regulate any company. To date, taxation has not been used significantly in the transportation industry as a method to encourage or discourage a specific behavior. Tax revenues have been used as a technique of financing for infrastructure development and maintenance for all modes except, until recently, rail.

Foreign Technology. Regulatory policies here and abroad will influence the availability of foreign technology for the United States transportation industry. For example, an impediment to use of foreign railroad cars and systems in the United States are U.S. safety regulations. As regulations become uniform throughout the world, then interchangeability of foreign and United States technologies will increase. In contrast, though, regulators are tightening their scrutinization of multinational companies' transfers of technologies. Technology transfer is further affected because surface transportation is an instrument of national policy in Europe and Japan. In France, for example, the French National Railway is an integral part of the nation's social security system, with a resulting adverse impact on efficiency. Nationalized airlines overseas also generally serve as instruments of national policy. These policies have direct technological implications; for example, note the implicit subsidies to British supplier industries in the cases of the Concorde and the RB-211 aircraft engine of Rolls Royce. Barring any return to isolationism as a foreign policy, centralization of regulatory authority combined with the rationalization of regulation could produce a climate more conducive to universal technology acceptance.

Hidden Goals of Regulators. It has already been noted that a large number of the regulatory agencies are staffed primarily by lawyers. Having lawyers perform economic regulation is something like having open heart surgery performed by a dentist. Unfortunately, the legal approach to problem solving tends to be backward-looking with reliance upon precedents for guidance. Too often, decisions are strongly shaped by what happened in the past rather than by the merits of the economic issues at hand. The net effect is that regulation is generally

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*For example, a nationalized health care scheme, if tried and successful could provide impetus for further nationalization efforts.

I. INTRODUCTION

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VOLUME 2

IDENTIFICATION OF ISSUES AFFECTING INTERCITY TRANSPORTATION

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X. THE IMPACT OF DEREGULATION

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ABSTRACT

This paper examines some of the probable changes which would follow "regulatory reform." In particular, regulatory philosophy and policies are considered.

Deregulation is politically popular because it is hailed as a cure for the poor economic performance of the transportation industries during the 1970s and because of its apparent return to the basic tenets of free enterprise, which allegedly, is the route to efficiency, profitability, and high-quality service. However, deregulation is more aptly called "regulatory reform" since it should not connote a return to a laissez faire role by the public sector.

Proponents of deregulation argue that major policy reforms must be carried out in three areas: entry and exit regulation, price competition, and industry structure.

Theoretically, entry/exit certification enables regulatory agencies to fine tune competition. Proponents of reform claim artificial restrictions on entry and exit creates stagnant franchise carriers. In markets where unregulated entrants have competed against the CAB-certificated air carriers, for example, the quality of service has increased dramatically and fares have declined.

The elimination of price competition induces carriers to compete in other ways. The air industry is, for example, notorious for its expensive advertising and alacrity in purchasing the most modern aircraft, practices which tend to increase fares and costs.

Reform would permit a "zone of freedom" for rates. Competitors would be allowed to offer several combinations of service quality and fares in order to best meet the demands of various sectors of the travel market.

Virtually all modes providing intercity passenger service are characterized by some form of monopolistic competition. Reform of industry structure, when coupled with relaxed restriction on entry and exit and on prices, could indeed result in shifts in the number and size of competitors in any given market. The key question will be the level of competition that will arise among the carriers currently existing and those which may emerge or drop out.

The ICC has shown little enthusiasm for deregulation; the U.S. DOT has tended to favor it, at least in part because of the Administration's policy of increasing the performance of the public sector. The Administration argues that regulatory reform in passenger air travel and rail freight can improve quantities and qualities of service and bring about lower costs. Opposite arguments--some well founded--argue that heightened competition will precipitate lower profits or even bankruptcy.

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Government's principal means of making reform is its ability to provide financial assistance.

Cross-subsidization is certain to be a major issue during any period of regulatory reform. Some economists argue that cross-subsidization and pricing discrimination are undesirable because they do not permit the market to equate freely supply with demand. However, cross-subsidization has long been a tool of public policy because it permits government to bring about socially desirable services in exchange for higher rates elsewhere. The important issue here involves the policy choice of economic efficiency versus social equity.

In general, regulators either explicitly or implicitly establish a reasonable rate of return. They are not averse to some degree of price discrimination as long as overall profits are reasonable. Reform proponents, in contrast, would achieve economic efficiency largely through marginal cost pricing.

Reforms would include: multimodal planning, centralized regulatory policymaking, centralized congressional oversight, and reduced reliance on precedence and legalistic procedures. The creation of a multimodal agency responsible for broad oversight of all transport might lead to increased horizontal and vertical integration. Consolidation of congressional oversight into centralized committees with responsibility over several transport agencies and several modes is a proposed reform step. Tariffs, certifications, and other carrier necessities must pass the hurdles of numerous steps, decisions, reviews, appeals, and reexaminations. Consequently, "regulatory lag" plagues the transportation sector.

As regulatory agencies have matured and ossified, reliance upon legalistic procedures has increased. Reduction, if not elimination, of this procedural labyrinth would be useful.

The Justice Department's antitrust division is exerting pressure for regulatory reform, as is the Council of Economic Advisors and the Office of Management and Budget. Support also comes from academic economists and from the consumer movement. Economists and consumer organizations do not, however, currently have enough political power. They need support from passengers and shippers.

Opposed to reform is the considerable weight of vested interests mostly concentrated in the carriers. The airline industry, the trucking industry, the motor bus industry, and organized labor generally oppose deregulation. Policies of some federal agencies also conflict with the aims of deregulation.

Public interest considerations must be considered if deregulation is to succeed, if legal and procedural battles are to be avoided. An ombudsman attached to regulatory agencies would be useful.

Noneconomic regulation also imposes a series of constraints upon the transportation sector. Inevitably, conflicts between transportation objectives and noneconomic regulations occur. The Concorde's battle to obtain authorization to land at U.S. airports is a prime contemporary example.

Accounting systems promulgated by regulators mandate inefficiency. Reform of accounting requirements should concentrate on developing both an enterprise information system and a regulatory information system so that the federal government can oversee the performance of the industry and make intelligent decisions on issues such as the measurement of avoidable costs, variable costs, asset base, investment requirements, fare and equitable rates of return, and economic profit. Managers and regulators alike are not capable of optimizing investment or technological decisions without a full understanding of the actual productivity of the capital stock in place. They do not know each asset's revenue contribution or cost burden; and thus, they cannot make informed decisions regarding replacement, innovation, abandonment, and service levels.

During the next quarter century, regulators will probably be compelled to become more cognizant of national economic factors, such as those which influence capital formation and supply and demand for investment funds.

A relaxation of certification policy for airlines will likely bring about a significant shift in the structure and degree of competition within the airline industry, the magnitude depending, in part, upon the extent to which cross-subsidization persists.

If market franchise regulations for intercity bus transportation are relaxed, then the marginal cost of entry would decrease, and a large number of independent bus operators might be generated.

Policies on highway user charges might be a product of reform. For example, if heavy trucks were made to pay a greater portion of highway system costs, their user charges would be revised upward, thereby inducing higher truck rates. In addition, if certification requirements for truck carriers were relaxed, the efficiency of existing carriers might be increased. Relaxation of certification requirements might also, in contrast, increase competition, thus forcing rates down to marginal costs and possibly driving many operators out of business.

X. THE IMPACT OF DEREGULATION

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X. THE IMPACT OF DEREGULATION

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What Is Deregulation?

The concept of deregulation of regulated industries has received great attention during the last year or so. Several bills providing for regulatory reform are presently awaiting congressional action. The Civil Aeronautics Board (CAB) is developing experiments to test deregulation in several city-pair markets. Deregulation is politically popular because it is hailed as a cure for the poor economic performance of the transportation industries during the 1970s. These industries have not enjoyed robust profits, growth, or stable prices. Indeed, several common carriers are in bankruptcy and others have come close. Few people doubt that the transportation sector has problems. Deregulation is often hailed as the cure because of its apparent return toward the basic tenets of free enterprise market behavior, which allegedly, is the route to efficiency, profitability, and high-quality service.

The term deregulation is probably not the best that could be used. Really, deregulation is a catch-all phrase for the reform of processes and techniques of regulation. Proponents of deregulation do not, however, envision a return to laissez faire economics. In fact, few policymakers really consider laissez faire as a feasible or desirable goal for this sector.

The purpose of this issues paper is to examine some of the probable changes which would follow "regulatory reform." The paper will look at the philosophy, the policies, the issues, and some of the possible examples of change that are expected to result from regulatory reform.

The Market Forces

Whether the movement is thought of as "deregulation" or "regulatory reform" its underlying aim is to "let the market work." One criticism is that market activities are severely distorted and hindered by regulatory intrusions. As a result, the goals pursued by regulated industries, in their pursuit of profits, are mutations of those of their counterparts in the unregulated sector. "Rational" policies and practices in a regulated industry are often foreign to those in the unregulated sector.

Some proponents of regulatory reform assert that if the managers of common-carrier transportation companies are freed from government "shackles" and are permitted to behave in a manner more akin to those in the remainder of the economy, the incentives of profit maximization would suffice to bring about improved transportation services. Many of

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the proponents of deregulation are acting out of a desire to see private enterprise management techniques prove that they are capable of providing an efficient national transportation system. Their notion is that regulation, no matter how well-intentioned, cannot function as efficiently as a good unencumbered manager. Proponents of this point of view argue that major policy reforms must be carried out in three areas:

- Entry/exit regulation
- Price competition
- Industry structure

The certification of common carriers by the regulatory agencies is one of the cornerstones of the regulatory system. Certification provides an exclusive or limited number of franchises to serve a city-pair market. Obviously, if the supply of such certificates is restricted by the regulatory agencies, then the economic power (and value) of holding a certificate is substantial. Proponents of regulatory reform feel certification has not achieved its theoretical purpose of bringing about optimum competition. Certification is needed because the natural monopoly character of the transportation industry means there is a limit on the number of firms which can efficiently serve a given market. To exceed this number creates competitive pressures that drive prices down below the level required to regenerate capital or, worse, cover operating expenses. Competition at such levels is often called cut-throat.

On the other hand, certification is a technique to assure that several firms engage in healthy competition. It helps to prevent a single enterprise from asserting monopoly powers in a market and thereby restricting output and driving up prices. (Of course, some markets are not large enough to support more than one carrier; and thus, only one certificate is issued thereby legitimizing a monopoly.) Theoretically, entry/exit certification enables regulatory agencies to fine tune competition. This fine tuning ought to move the market toward an optimal number of competing firms providing a given quantity and quality of services at the lowest possible cost. To date, the performance of the regulators in this respect has been poor. Proponents of regulatory reform claim artificial restrictions on entry and exit lead to a lack of responsiveness on the part of the franchised carriers. That is to say, these carriers provide quantities and qualities of service inferior to those offered in similar markets with greater competition. The well-publicized cases of the intrastate airline markets are the chief ammunition of the critics of the performance of these regulatory agencies. In markets where unregulated entrants have competed against the CAB-certificated air carriers (California and Texas are the best examples), the quality of service (e.g., frequency) has increased dramatically and fares have declined.

If deregulation comes about, it is likely that many of the major city-pair transportation markets in the United States will see less restrictions on competition. Total withdrawal of certification requirements is remote, but new entrants into these markets should be expected. For

instance, if air service between Chicago and New York was deregulated, airlines such as Ozark, Continental, and Delta, which are not presently permitted to serve this market, might well compete with those carriers presently serving it. The present competitors (American, TWA, and United) might choose to increase or decrease their quantities (and qualities) of service. Overall though, Chicago-New York air service is expected to improve.

The second area in which the relaxation of regulation should lead to changes is price competition. The theory of regulation holds that these industries are "public goods" and that their rates should be held to low levels in order that the public may consume a greater quantity of output. Just the reverse, however, appears to be true. Government policy has, in fact, established a floor on rates which has evolved into creation of an artificially high level of rates. Indeed, this situation is doubly bad because the elimination of price competition induces carriers to compete in other ways which have the effect of pushing up costs and fares. The air travel industry is notorious for its extensive advertising and alacrity in purchasing the most modern aircraft. Both tendencies are traceable to a "rational" objective to differentiate their services from those of their competitors. Since regulatory policy prevents one carrier from holding back on fares while the others raise theirs, the risks of adding new costs are lessened because they are recapturable in the air fares. The net effect of these competitive practices is that the passenger's price for air travel--air fare, plus other costs--is pushed upward.

A regulating reform will remove some restrictions on price competition by permitting establishment of a "zone of freedom" for rates. Competitors would be allowed to offer several combinations of service quality and fares in order to best meet the demands of various sectors of the travel market.

The third major focus of this market-oriented philosophy is the structure of the transportation industry. Virtually all the modes providing intercity passenger service are characterized by some form of monopolistic competition.* The reformers' theory is that competition should be encouraged by stimulating the competitive environment of the transportation industry. In other words, more carriers and possibly carriers of different sizes should be allowed to compete. The aim is not cut-throat competition leading to a collapsed industry, but rather a finely tuned market encouraging innovative changes in technology and low fares with efficient operations. Reform of industry structure, when coupled with relaxed restrictions on entry and exit, and on prices, could indeed

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*The one notable exception is AMTRAK, a pure monopolist whose behavior is similar to that of the monopolistic competitor anyway, since it makes its competitive decisions on the basis of airline and bus prices.

result in shifts in the number and size of competitors in any given market. It is not certain in what direction these shifts would take place. For example, depending upon the exact degree of deregulation in the airline industry, there might be increased or decreased concentration (of ownership) in the industry. A major deregulation would probably lead to consolidation into half a dozen or so major trunk carriers as a result of mergers among the smaller airlines. Many smaller airlines simply would not be able to withstand competition from the massive nationwide carriers like United. However, if the extent of deregulation were less drastic, the most efficient carriers--intermediate-sized carriers--might well emerge as very strong competitors.*

It is not possible to forecast the exact lines upon which industry structures would develop in a climate of substantially relaxed regulation. The key questions will be the degree of monopolistic competition that will arise among the carriers currently existing and those which may emerge or drop out. The role of the Justice Department will be important here. Some reformers call for the Justice Department to take responsibility for industry structure matters (particularly, antitrust matters), which historically were given to the regulatory agencies. The theory is that the Justice Department is better equipped to consider issues of industry structure and that it should make policy for all industries rather than leaving this authority to the economic regulatory agencies.

Another major issue affects market-oriented regulatory reform. Over the years, the regulators and the regulated industries have built up close ties. The agencies and the carriers have grown interdependent and nurture one another. The current moves toward reform in the CAB are practically unprecedented and can be explained as the policy of a new administration supplanting one which was considered to represent adequately the public interest. The Interstate Commerce Commission (ICC), on the other hand, has shown little enthusiasm for deregulation and such impetus for reform of surface intercity passenger transportation as can be seen has emanated largely from the U.S. Department of Transportation (DOT), at least in part because of the Administration's policy of increasing the performance of the public service sector. The Administration would like to see less reliance on government aid--financial or other--to transportation companies. In the passenger air travel and rail freight contexts, the Administration feels regulatory reform can improve quantities and qualities of service and bring about lower costs. Opposition from within the industry emanates from many sources for many reasons. Among those reasons are fears--some of them well-founded--that heightened competition will precipitate lower profits or even bankruptcy. Others oppose the relaxation because they have carved out a lucrative niche in the marketplace which could be disturbed by government-mandated reforms such as decreased certification requirements and price competition.

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*By most leading indicators, the most efficient carriers, Braniff, Delta, National, and Northwest do belong to this category.

The best incentive to make these reforms palatable in the industry is money. The most immediate battleground is the freight railroad and the Administration is attempting to reform regulations in this area by offering financial assistance to revitalize the industry. Many of the new proposals are bitterly opposed by vested interests; but by packaging the reform with financial assistance, the Administration forces the railroads to accept them. For example, the government is providing financing for the continuation of branch-line service, for rehabilitation, and for other "uneconomic expenditures" in exchange for an end to such collusive practices as rate bureaus.

In summary, the regulatory reform movement is largely market-oriented. It seeks greater incentive for increased price competition and facility of entry and exit to bring about better operational performance. The government's principal means to make these reforms palatable to the industry is its ability to provide financial assistance.

Pricing Policy. Cross-subsidization is certain to be a major issue during the period of regulatory reform. One instance during which it occurs is when there is discriminatory pricing between various "products" of a producer. In the common-carrier transportation industry, users often pay fares that are not proportionate to the marginal costs of the service; rates can be relatively high (or low) for various types of services on various routes at various times of day, at various times of year, or between various commodities. Some economists feel that cross-subsidization and pricing discrimination are undesirable because they do not permit the market to equate supply with demand freely. However, cross-subsidization has long been a tool of public policy, because it permits the government to bring about socially desirable services in exchange for higher rates in other sections of the carriers' operations. In the future, the issue will be: should the government continue to distort the market mechanism by setting up incentives to produce a particular service that would not otherwise be produced, or should it make direct payments for socially desirable services, or should discontinuance come about? At issue here is an important question of economic efficiency versus social equity.

At present, carriers establish most of their prices at least in part on a value-of-service basis. In other words, to the extent allowed by the regulators, they price their services at whatever they perceive the market will bear. The regulators "oversee" the process to try to prevent excess or cut-throat competition. In general, the regulators either explicitly or implicitly establish a reasonable rate of return for the industry and are not averse to some degree of price discrimination by carriers so long as the carrier's overall profits are reasonable. The regulatory reform movement, in contrast, would achieve economic efficiency largely through marginal cost pricing. If such a policy were adopted, generally, many currently legitimate forms of economic discrimination (pricing, market segmentation, certification, pooling) would come into question. It does not mean that multitiered rates will

disappear. On the contrary, marginal cost pricing might lead to the establishment of an even broader variety of qualities of service at different prices. Thus, different prices would be charged, but each would be based upon marginal cost. Multitiered rates do exist today in air passenger transport, but the marginal cost differentials do not convincingly reflect the rate differentials. Freight services, especially in the surface modes, are particularly noted for value-of-service pricing. Here, a restriction is an unrealistic ICC formula setting a "floor" under prices, which is supposed to be equated with variable costs. In the long run, the most controversial feature of regulatory reform may prove to be the new policy on pricing.

Procedural Reforms. The regulatory agencies are infamous for the elaborate process which has evolved for the handling of a proceeding. Tariffs, certifications, and other carrier necessities must pass the hurdles of numerous steps, decisions, reviews, appeals, and reexaminations. These procedures, which are the result of many years of assiduous work by many lawyers, now result in the famous "regulatory lag" which plagues the transportation sector. Studies have demonstrated that even technological innovations have been delayed or simply not implemented because of the procedural hurdles. However, this regulatory lag does protect the status quo carriers, dulling the propensity to innovate, at least where demand-stimulating innovation is concerned.

Regulatory reform should move toward consistent and streamlined governmental planning and control over transportation. These reforms would include:

- Multimodal planning
- Centralized regulatory policymaking
- Centralized congressional oversight
- Reduced reliance on precedents and legalistic procedures.

A principal problem of the regulated industries, as Congress is apparently aware, is the serious fragmentation of federal responsibility. Too many agencies are authorized to supervise various aspects of the transportation industries. Authority overlaps, and there are blind spots, inconsistencies, and conflicts. In Congress for instance, transport regulation is divided among a great number of subcommittees. In several cases, one executive branch agency is overseen by more than one congressional subcommittee. The consolidation of congressional oversight into centralized committees with responsibility over several transport agencies and several modes is a step for which some reformers have called, though such a position collides head-on with vested political footholds.

An obvious proposal is the creation of a multimodal agency responsible for broad oversight of all transport--freight and passenger. Such a step might lead to increased integration such as horizontal consolidations across several modes. Vertical integration might also come about. Transportation conglomerates might be another outgrowth of a multimodal regulatory agency.

The fourth major reform directly related to procedure which is likely to emerge in regulatory reformation is a de-emphasis of procedural rules and precedent as the framework and guiding lights of regulatory decision-making. As regulatory agencies have matured and ossified, reliance upon legalistic procedures has increased, as an ever larger body of precedents is accumulated for procedures, modes of relief, and appeals mechanisms. (For more, see issue paper "Impacts of Regulation on Intercity Transportation.") A fresh start in some areas would greatly reduce, if not eliminate, the procedural labyrinth of the regulatory agencies. If these agencies were renewed or replaced, the labyrinth might be eliminated, at least at the beginning. One idea which has received some support in Congress is to place a time limit on all regulatory agencies. The Federal Energy Administration was established for a limited term. If this precedent were adopted, a regulatory agency might not become so completely bound and thus a burden upon the industry and upon society.

Principal Proponents of Regulatory Reform

Much of the impetus for deregulation or regulatory reform has recently come from the federal government. The Department of Transportation, established long after most of the regulatory agencies, has been seeking a greater role in the formulation of transportation policy and in the conduct of economic regulation throughout the transportation industry. The new Secretary of the Department of Transportation, William Coleman, with the backing of President Ford, is considered a proponent of regulatory reform and extensive deregulation.

The Justice Department, particularly its antitrust division, is another government agency exerting pressure for regulatory reform. Arguments emanating from the antitrust division suggest that the reasons for exempting the transportation industry from the antitrust laws are no longer valid and that airlines, railroads, etc., should be subject to the same rules as other sectors of American industry. The Council of Economic Advisors and the Office of Management and Budget also add impetus to the deregulation pressures. In theory, this policy's effect would be heightened competition and bring about a more efficient transport system.

Outside the federal government, support for deregulation comes from academic economists and from the consumer movement. Regulation, it is claimed, costs billions of dollars every year and provides insufficient offsetting benefits. Their belief is that the improved efficiency from

removal of the regulatory shackles will outweigh the benefits of government intercession in the process of transporting people.

One problem the regulatory reform movement must face is that, except for what might be interpreted as an internal power struggle among various departments of federal government, it has very little political power. Academic economists and Ralph Nader's Aviation Consumer Action Project simply do not currently have enough political weight to push reforms through Congress. They will need to recruit support from passengers and shippers.

Opposed to the regulatory reform movement is the considerable weight of vested interest mostly concentrated in the common carriers. To begin with, the regulatory agencies themselves have developed a "mandarin system" very different from other institutions in American economic and political life. These institutions obviously have a strong interest in bureaucratic self-preservation. For the most part, the transportation industry, especially sensitive in difficult economic conditions, opposes regulatory reform. This is perhaps least evident in the railroad industry, where such major upheavals as the Regional Rail Reorganization Act have overshadowed regulatory reforms. However, the airline industry is almost unanimously opposed to the Administration's most recent regulatory reform moves, with only United Air Lines, the nation's largest, unequivocably supporting deregulation and Braniff, a relatively strong intermediate carrier, indicating limited support for regulatory reform. Other major carriers, especially TWA, feel that in the current economic climate any relaxation of regulatory supervision (or, as they see it, protection) would lead to their downfall. The trucking industry and the motor bus industry are equally opposed to deregulation in their fields. Organized labor also generally opposes relaxation of regulations in the transportation industry at the present time.

Countervailing Forces

Even though regulatory reform is official Administration policy, the specific reforms will not be implemented without opposition. Besides the many vested interests that must be overcome, there are federal government policies which will conflict with the aims of deregulation. The consumer movement could emerge as an opponent of regulatory efficiency. While consumerism and the public interest are not in conflict with regulatory reform *per se*, the consumer movement has often been forced to rely upon the procedural labyrinth of regulatory agencies in order to obtain objectives which they could not obtain on substantive grounds. For example, opponents of the Penn Central's attempt to abandon the Harlem Valley line lost a long series of procedural battles before the ICC until they brought suit contending that the railroad's abandonment petition was deficient in that it lacked an environmental impact statement. Although an environmental impact statement had never before been required in an abandonment petition, the court held that such an analysis would have to be carried out. Although the

environmental issues are not the paramount concern of the opponents of abandonment, this tactic served to place a major obstacle in the railroad's attempt to end that service. This procedural tactic added several more years of delay to abandonment. The issue has not been decided on substantive grounds but the effect of years of procedural wrangling has been to give at least a temporary victory to the opponents of abandonment.

This example demonstrates that adequate voice for public interest considerations must be included in the reformed regulatory system if it is to succeed. Unless given an adequate voice in the new regulatory environment, the general public will almost certainly fall back on the same tactics which have been successful in the present regulatory environment, i.e., legal and procedural battles. In the new regulatory climate, there will probably have to be an ombudsman attached to regulatory agencies. The principle of the ombudsman has begun to gain acceptance in the United States both at the federal and state levels. Planning for the reorganization of the Northeast railroads was strongly influenced by the Office of Public Counsel which was specially set up within the ICC to articulate the viewpoint of communities and users of rail services. The public counsel concept should be thoroughly examined as part of the regulatory reform movement. If the legal and economic interests of the public are not adequately represented under any new system, it will be unworkable.

A related series of constraints is imposed upon the regulated industries in the form of noneconomic regulation. There is now a multitude of regulatory bodies in the United States with authority over everything from factory safety to the type of communications equipment which may be used. Such regulatory agencies include the Environmental Protection Agency, the National Transportation Safety Board, the Federal Energy Administration, the Occupational Safety and Health Administration, etc. Each of these agencies fills a socially desirable function, but as they expand their influence by highly specific regulations, they impose requirements on the transportation sector. Inevitably, conflicts between transportation objectives and noneconomic regulations must occur.

The Concorde supersonic aircraft's battle to obtain authorization to land at U.S. airports is a classic example of a major confrontation of multiple-regulatory intercessions in the transport sector. Involved in this proceeding are the following forces:

- Safety--Should the Federal Aviation Administration make a determination as to whether the aircraft is airworthy? Or is the certification of the British and French governments sufficient?

- Environment--Does the National Environmental Policy Act apply to international air travel movements into and out of the United States?

- Foreign Policy--Do the bilateral agreements between the United States, France, and Great Britain supersede laws enacted subsequent to them? Do the provisions of these treaties rightfully influence policies outside of air transport?

- Economic Viability--Should any federal agency be concerned with the economic viability of the Concorde operations? What about the energy efficiency of the service?

Not surprisingly, the nexus of all of these issues is concentrated into the seemingly unimportant decision as to whether the aircraft will be allowed to land at an airport. Fortunately, the responsibility for making this far-reaching decision is not in the hands of a middle-echelon FAA bureaucrat. Rather, Secretary of Transportation Coleman is responsible for making the decision based upon all of the above factors.

Nevertheless, there are many inefficiencies in this process to which the Concorde is subjected. First, the fact that the landmark decision is made in the context of the rights to land is absurd. The arguments are over whether the Concorde is good or bad for the United States, but inappropriately, the forum for resolving the controversy is the FAA (issuer of landing rights). The second deficiency of the process is that many of the proponents and opponents of the Concorde have strayed afield from their areas of expertise. Certainly, comments with respect to other fields should be elicited from environmentalists, safety experts, meteorologists, and so on. However, they should not misinterpret their role--they are needed to provide worthwhile technical inputs, and not opinions upon matters such as the economic viability of Air France's supersonic air service. Third, the entire Concorde proceeding has incredible implications upon the development of technology. Unfortunately, comment upon the impact of any decision on the process of innovation in air transport has been relegated to low-level importance. A remedy to this oversight would be to compel regulators to incorporate into their decisions an assessment of the impact of their policy upon technology. (In the Concorde case, the EPA standards to which the innovation is subjected are standards which are not even applicable to aircraft built before 1969. That is to say, this innovation in its early stages of commercial development, is being forced to meet a stringent set of noneconomic criteria to which most aircraft innovations have never before been required to comply. Indeed, do such regulations in and of themselves, act as impediments to technological innovation in air transport?) The fourth problem regarding this decision-making process is the fact that Secretary Coleman is not really the repository of all authorities with respect to whether the Concorde can serve the American market. The Port Authority of New York and New Jersey can effectively prohibit the plane from landing in the New York metropolitan area. The State of New York has interceded, and of course, the ubiquitous barrage of lawsuits may very well continue. In summary, the Concorde case illustrates the inability of the existing regulatory framework to deal with an issue on the merits of all factors of importance. It shows that the procedural framework for handling such decisions can be prostituted as an effective

weapon to impede the introduction of change. Furthermore, it demonstrates that the awareness of the process of technological innovation is absent even in the case of one of the leading technological innovations of the decade.

Some Possible Changes

Whatever one's point of view on regulatory reform, it seems certain that many of the regulations imposed by the federal agencies have made management less efficient.

Accounting Systems. Among the best examples of government-mandated inefficiency are the accounting systems promulgated by the regulatory agencies. Through the years the ICC, for example, has built up its own set of accounting principles divergent with those of the Accounting Principles Board. Many of these principles are completely different from the standard procedures used virtually everywhere else in American industry. That is not to say the Accounting Principles Board rules are uniformly preferable, but many required practices in the rail industry have fallen behind modernizations elsewhere. Managers in regulated industries have had to rely upon these anachronistic accounting principles to make their decisions. Strange as it may seem, in many cases accounts kept under the ICC principles were the only set of accounts available to management. It is therefore no wonder that many statistics and decisions based on these statistics in the transportation sector seem anomalous. One reason that railroads report a seemingly low return on assets is the fact that assets are carried on the books at the original cost until they are removed and retired (i.e., there is no depreciation allowance for fixed assets).

It seems clear, therefore, that regulatory reform must involve reforms in accounting and reporting requirements. The new accounting system will have to serve two very important needs with respect to enlightening carriers and their regulators to technology. First, it should not be merely a set of balance sheets but an enterprise information system. It should function as a managerial information system for the operator. Managers need information on replacement costs, opportunity costs, avoidable costs, cost by city-pair market, service type, and equipment type. Second, the accounting sytem should also work as a regulatory information system so that the federal government can oversee the performance of the industry and make intelligent decisions on issues such as the measurement of avoidable costs, variable costs, asset base, investment requirements, fair and equitable rates of return, and economic profit.

In effect, the regulatory agencies at least should consider seriously a complete reform of their reporting requirements to conform more closely with modern managerial accounting principles. It is important that the regulatory authorities act as a stimulus to efficient management

decision-making. Some of the important issues that ought to be addressed in the reform of the accounting system should be the reporting in a segregated manner of such illusory profits as inventory profits, profits in excess of book value on salvaged or disposed assets, profits due to currency fluctuation, etc. The elimination of these extraordinary and noneconomic accounting profits helps to make the statement of net income much clearer and provides the regulators with a better understanding of obsolescence, replacement value of assets, and appropriate rates of return.

The technological implications of accounting reforms are not obvious, but they are critical. Managers and regulators alike are not capable of optimizing investment or technological decisions without a full understanding of the actual productivity of the capital stock in place. They do not know what each asset's revenue contribution or cost burden is; and thus, they cannot make informed decisions regarding replacement, innovation, abandonment, and service levels.

Economic Planning. During the next quarter of a century, regulators will probably be compelled to become more cognizant of national economic factors. Because of the anticipated materials shortages and reduced supplies of capital funds, the regulators must become more sensitive to factors which influence capital formation and supply and demand for investment funds in the overall economy. Regulators must employ more foresight in identifying bottlenecks in the production function of the industry under their regulation. That is to say, better advanced planning will be required to procure the funds required to remedy a particular problem because delay in raising capital and purchasing new assets may be severely prolonged due to the capital formation gap. Otherwise, the industry may be forced to suffer through a period of stress due to a severe shortage of a particular asset in its production function. These problems will force the regulators to view broad issues of investment policy, private financing, debt/equity ratios, indenture agreements, reporting requirements, and other principles of finance.

In essence, regulators must be tuned into national economic trends which are too important to ignore. For example, in the late 1960s when the air traffic controllers imposed slowdowns on air travel because of the severe demands on their capabilities, the need for improvements in the airways system became glaringly obvious. Air traffic control was a bottleneck in the air transport production function. Macroeconomics comes into consideration because the solution to the airways crisis took several years of investment in manpower training and installation of electronic equipment. However, if in the future the supply of capital for such programs becomes harder to obtain, then the regulators (e.g., FAA) must forecast problems like the air traffic control constraint. Otherwise, the lag time until the problem is alleviated may be dramatically stretched out.

This need for macroeconomic enlightenment is heightened by several other emerging phenomena. One is the requirement for investment expenditures on assets which, in reality, do not contribute to the profits of the firm. Such assets are pollution-abatement equipment or safety equipment. Obviously, these investments are socially desirable and have been mandated by forces external to management. Perhaps it would be appropriate for these expenditures to be identified separately. Then, regulatory policies regarding rate of return on assets could be segregated across the income-producing assets and the nonrevenue-bearing assets to aid in the analysis of regulatory decisions aimed at providing a rate-of-return on an asset or base of assets. When significant nonrevenue-generating assets are added to the asset base of a carrier under rate-of-return regulation--the case for most passenger carriers--the regulator must make an important policy decision regarding how additional revenues will be earned to pay for the investment. In most cases, that question means where should prices be increased to pay for the asset?

It is not suggested that the regulators require the management of these enterprises to separate the entire company's array of assets into income-producing and nonincome-producing (i.e., safety, pollution abatement, noise abatement) assets. For adminstrative reasons, separate identification for nonincome-producing assets should probably not begin until some threshold value is reached in order that the accounting problems defeat the whole idea.

It is likely that sometime during the next ten years several rounds of investment in nonrevenue-producing assets will be required in the intercity transportation market. One example will be buses which may be forced to comply with new safety and pollution requirements. AMTRAK may be required to improve the sanitation specifications in equipment. The airlines may be required to undergo another retrofit program to reduce the noise and/or pollution of their engines. If any of these or similar investments amount to a substantial portion of capital asset acquisitions in any given year, then the regulator should seriously consider requiring the accounting of these purchases to be separately identified.

Several Future Cases of Reform

Airlines. A relaxation of certification policy for airlines will very likely bring about significant shifts in the structure and degree of competition within the airline industry. The magnitude of these changes will depend, in part, upon the extent to which cross-subsidization actually persists. Carriers may simply abandon unprofitable markets if exit requirements are relaxed. However, if there were also a relaxation of price restrictions, a market might be provided with several different levels of service qualities. In the recent past, trunk and local service air carriers have withdrawn from several dozen light-density markets, but the abandoning certificated carriers have been responsible for insuring continued service through a third level carrier. When exit requirements were relaxed, different aircraft and different frequencies

were substituted into these markets. In the future, relaxed entry and exit requirements might induce the introduction of less technologically advanced aircraft into the trunk markets in an attempt to offer a somewhat lower quality of service at a lower price to a latent sector of the market seeking price reductions in air service.

If the air travel market should become segmentized into different levels of service, there may be profound implications for airport development. Up to now, airport investment has been almost totally determined by the expectations of the certificated air carriers. These expectations have been based on their ability to induce air travel, which, in turn, is a function of the economic prosperity of the nation. Airport development is also greatly influenced by technology. In the future, therefore, if airlines continue to operate older jet aircraft, the pace of airport development will change. Facilities will not become obsolete as rapidly as in the past. Thus, if the life of a B-727 or a B-707 is extended and if the air carrier is not particularly concerned with elaborate ground facilities, then more austere airport facilities will be built or retained in service.

An example of what might happen is shown in the competition between Southwest Airlines (an intrastate air carrier) and the certificated air carriers serving the new Dallas-Ft. Worth Airport (DFW). Southwest perceived that its market lay in no-frills, low-cost service with high frequencies to major Texas cities. It opted for the less exotic but cheaper and more convenient Love Field for its operations, while the certificated carriers moved out to the luxurious new DFW 25 miles further away. The lesson from Texas seems to be that the relaxation of the regulations against competition may bring about several qualities and prices of service along with a deceleration of the rush toward new technology.

Trends toward cost-savings reductions in air transport may result in some interesting situations. For one, the existing airport infrastructure could become prematurely obsolete in lieu of cheaper facilities. Since the airport owners and the airlines often bear joint liabilities on the financing of the facilities, the two parties may resolve to perpetuate the existing institutions. However, airlines like Southwest or PSA may capitalize on the certificated carriers' commitments to the existing institutions by heavily marketing a stripped-down, no-frills service. Already, others are seeking to provide "skybus" or "skytrain" service. In exchange for major fare reductions, these services entail few of the ancillary amenities available with coach-class service. Success of no-frills services will force a complete reevaluation of the notion of conventional air service: what level of sophistication in aircraft, airport design, ticketing, and baggage handling are warranted by market demand?

Bus Service. The withdrawal of restrictions on entry and exit from the intercity bus transportation market could have some interesting and, as yet, unpredictable effects. Presently, intercity bus transportation is provided by several large carriers along with many regional carriers. If market franchise regulations were relaxed to the point that entry and exit were virtually unrestricted, then the marginal cost of entry would, on the margin, consist of the driver's wage, plus fuel, plus rental of bus. Thus, one might observe a proliferation of a large number of independent bus operators in many cities. A new phenomenon that might also follow is the deferral of maintenance of the buses. If an operator were locked into a competitive struggle with another company, then deferral of maintenance might be his logical way to preserve a positive cash flow.

Highway User Charges. Still another realm in which relaxation of regulations would have profound market effects is highway traffic. If policies on user charges were revised, then one might expect various segments of highway traffic to rise and fall depending on the directions of these changes. For example, if heavy-truck users were made to pay a greater proportion of their costs on the highway system, user charges would be revised upward thereby inducing higher truck rates. In addition, if certification requirements for truck carriers were relaxed, two types of changes might occur. There might be an increase in the efficiency of existing carriers, since it is alleged that the ICC's circuitous routing requirements drive up costs. But, on the other hand, relaxation of certification requirements might also increase competition, thus forcing rates down to marginal costs and possibly driving many operators out of business. Not knowing the net effects of deregulation means that the technological implications are indeterminant. For instance, regulatory relaxation could increase or reduce congestion depending upon incentives to use other modes, to use efficiently sized vehicles, to schedule movements in off-peaks, and to design more cost-effective equipment.

XI. ORGANIZATIONAL AND REGULATORY ISSUES

by

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ABSTRACT

Nineteenth Century rail organization forms have engendered the current decline or collapse of numerous private railways. Contemporary organizational and technological innovations borrowed from other intercity transportation (ICT) modes and elsewhere can revive the railroads.

The ICT industry as a whole is in financial distress. Entrenched organizational cliques are locked into rigid pricing-service schemes. Industry-labor institutions form a bilateral monopoly. Restriction of competition has led to noncompetitive price-making and cartel formation. Artificially high prices have allowed noncartel producers to enter the market with a resulting decline in the market share of professional carriers and an increase in excess capacity (especially in passenger transport, and more recently, in freight transport).

The quality of ICT varies generally with proximity to, and availability of direct access to, major termini or "nodes", which may be different for each type of technology. In the case of urban termini, inadequate internal urban transport links to access routes of ICT may have detrimental effects.

The development of current ICT is the result of historical accident. Locomotion by steam power preceded the inventions of portland cement and rubber vulcanization. The inflexibility of rail technology militated against multiple-user access without centralized traffic control. Railroad construction required immense capital investments, which led to (1) excess capacity, since construction preceded demand; (2) varying price policies, depending upon economic viability of the competition; and (3) merger of competitors because of excess overhead. Discriminatory price policies led to the genesis of state and federal railroad regulatory commissions.

During the period between World War I and the 1930s, new competitive transport technologies emerged, and regulatory agencies began stringently enforcing "entry control." The imposition of 19th Century railway organization on both the railroad industry and new technologies stifled innovation. World War II gave the railroads a lease on life, but the postwar years witnessed the progressive decline of the rail system, an increasing number of rail bankruptcies, and the rise of competing technologies.

Alternative remedies for the rail crisis are revenue increases and cost reductions. Higher prices have, however, driven rail traffic to competitors, and rail-service quality is deteriorating. More plausible solutions are, therefore, to reform labor agreements to reduce train manning (and, therefore, labor costs) and to restore track conditions to increase train speeds (and, therefore, labor and capital productivity).

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Most current policy options, including the sequence of reports mandated by the Regional Rail Reorganization Act, are limited by 19th Century notions of acceptable railway operation; bankrupt railways must be treated systematically.

The United States Railway Association (USRA) Preliminary System Plan to reorganize the bankrupt railroads envisions a three-carrier system (ConRail, Norfolk and Western, and Chessie). The Railway Services Planning Office (RSPO) of the Interstate Commerce Commission (ICC) evaluation of the USRA Plan proposes a four-carrier alternative system, some of the bankrupts included in ConRail being shifted to a new system, MARC-EL (Middle Atlantic Rail Corporation plus the Erie Lackawanna). The financial plans for ConRail include massive rehabilitation expenditures, with varying rehabilitation priorities assigned to different lines, and a capital structure of debentures, preferred stock, common stock, and certificates of value, to be variously held by the government or distributed as payment to the bankrupt railroads.

ICT entry control should be abandoned; free entry makes price control unnecessary, opens the industry to innovative entrepreneurs, and increases competition; rail track would become a public turnpike, and trackage rights would be available to anyone paying the toll; present freight forwarders and leasing companies would form the nucleus of a new group of entrepreneurs. No significant capital investments are needed due to the existence of railroad equipment trusts and the proliferation of privately owned railway cars, which are becoming a more attractive investment for private capital. Much of the needed private business organization already exists; lease management companies act as brokers between investor-owners of railway cars and user companies. Labor supply could be provided by waterfront-type hiring halls like those of the International Longshoremen's and Warehousemen's Union or by independent contractors. Railway traffic controllers could be Federal Railway Administration employees, independent contractors, or other government employees, using two-way radio technologies. Terminals could be leased by a local government owner to an entrepreneur-operator or to local industry cooperatives; terminal use charges could be billed separately to encourage through runs. Bulk shippers would use unit trains as part of their industrial processes, and over-the-road common-carrier truckers would use flat cars for containerized trailer transport.

The availability of federal modernization and maintenance funds would help to spur even solvent roads to abandon 19th Century organization concepts and to offer trackage rights to others. Main lines would be federally funded; other lines would be state or local responsibilities.

Regulatory agencies have generally misallocated resources in the ICT industry, causing higher transportation and consumer costs. The primary disincentives to industry innovation are rate-regulation policy and the "common-carrier" concept. Regional regulatory rate bureaus

catalyze agreement on a common set of rates, and the resultant intramodal noncompetitiveness with respect to prices stifles innovation. The statutory, common-carrier concept mandates carrier maintenance of a large excess standby capacity, causing excessive overhead costs and preventing innovation. Rate flexibility will provide the industry with a fair market return and periodic profits--the *sine qua non* of innovation.

Two overall approaches exist to rectify the problems of ICT. One approach is to subject all carriers to regulation; the Interstate Commerce Commission (ICC), Civil Aeronautics Board (CAB), and railroads have all advocated an extension of regulation. The alternative approach is to eliminate entirely all regulation in the ICT industry; the authors advocate this position. In dealings with outsiders, regulatory agencies tend to protect the interests of existing regulated carriers rather than to consider future benefits of innovation for the shipping and traveling public, and they look for reasons to deny industry entrance to newcomers. Recent experience has shown that unregulated carriers in competition with regulated ones tend to be more innovative and to provide better services at lower rates. Overall deregulation should provide a major boost for innovation in the ICT industry.

XI. ORGANIZATIONAL AND REGULATORY ISSUES IN INTERCITY RAIL

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XI. ORGANIZATIONAL AND REGULATORY ISSUES IN INTERCITY RAIL

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Where We Are in Domestic Intercity Transportation

Intercity transportation (ICT) service lacks the popular visibility of urban transport, but it nevertheless suffers from many deficiencies. Some of those deficiencies are inherent in the technologies in the sometimes requisite transfer between the urban vehicle and the intervention vehicle. Most of the deficiencies we have voluntarily imposed on ourselves through the political process. The result has been an asymmetric web of restrictions on entry, service, and price.

We have a number of competing technologies. Except for rail and pipeline, the track and controls are publicly provided. Terminals are public for sea and air transport, mixed for highway. The vehicles are almost always privately provided.

Rails offer an anomaly: track and terminals are privately provided, as are freight cars, but passenger cars are publicly provided. Petroleum pipelines are wholly private. A charge is made for the use of most publicly owned facilities. Whether that charge is at an appropriate level is the subject of long-standing and often acrimonious debate.

ICT may be divided into private and public. In this context, public refers not to ownership, but to the professional nature, the offering of the service. Most ICT is private; that is, persons are transporting themselves and/or their property. Professional carriers are for hire; they carry for others.

Private carriage is unregulated, except for safety requirements imposed on operators and their vehicles and various taxes. But by unregulated is meant that anyone meeting the technical requirements of personal competence and vehicular safety, and paying the standard fees, may move himself and his property in ICT without further permission.

Professional carriage is, however, severely restricted. With a few notable exceptions, no individual or company may enter the ICT business without advance permission. That permission is specific technologically, geographically, and in terms of what may be carried. A second important restriction is that carriage prices and conditions of service must be published and adhered to. Proposed changes must be published in advance and may be subject to delays, hearings, and cancellation by the regulatory authorities who exist at both federal and state levels. Nor are the various technologies of professional ICT subject to identical regulations.

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The private business organizations which constitute the professional carriers are typically restricted to a single technology. A few receive payments specifically identified as subsidies; there remains, however, uncertainty whether fees, taxes, and prices of most professional carriers are appropriate.

Cross subsidization of services provided by a single professional carrier is common. That is, profits on some segments of professional carriage are dissipated by losses on other segments.

Total ICT has had great growth, principally in the private sector. Restrictions of professional carriage have produced a clique of long-established organizations with rigid pricing and service standards. Labor relations have come to represent a form of bilateral monopoly.

By the 1970s, professional ICT is in financial difficulties. All segments of professional ICT show declining earnings. Rail and air transport organizations often show accounting losses, and many rail organications are bankrupt.

The restriction of competition by regulation encourages noncompetitive price-making. Pricing seems to approximate the theoretical solution: prices are initially set high enough to keep the weakest producer in business and all producers have, as a consequence, excess capacity. Producers outside the cartel are encouraged to enter under the shelter of cartel prices. Translated into the domestic ICT situation: professional carriers have priced themselves high enough that shippers find it worthwhile to develop their own private transportation, and professional carriage handles a declining share of the market. In passenger transport, for example, more than 80% of intercity passenger-miles are produced by the private car; freight transport is exhibiting a similar tendency.

The quality of ICT is spotty in a random fashion. ICT can be seen as an organization of nodes or major termini which vary by technology. Service between nodes is often very good; service radial to the nodes is likely to be good. But service between points across the nodal radii may be poor to nonexistent.

For all technologies, the nodes include the major port cities along the coasts. For air transport, the other nodes tend to be headquarter cities of the trunk lines: Atlanta, Dallas, Chicago, and Minneapolis. For rail transport, the nodal points are more diffuse and, typically, represent transshipment and/or junction points of the 19th Century. Highway transport is usually good along the Interstate system and elsewhere if the limited access highway is dominant. In some older parts of the country, conventional roads and streets were designed long ago; in those areas, the Interstates contrast so favorably with the older system (or nonsystems) that they are heavily congested.

Travel by air along routes not radial to nodes can be difficult. For example, the *Official Airline Guide*[1] shows no air service at all between Louisville and Columbus, Ohio. Adequate service to both cities is available from Chicago, but use of the radials to and from that city more than doubles the travel distance. It is possible to develop connecting service via Dayton or Cincinnati. Those connections always involve a change of carrier. No interline fares are available; hence, full terminal charges must be paid twice. Rail service takes about 30 hours and involves inconvenient arrivals at both the junction point and the terminal. But Greyhound has several daily schedules, and the Interstate is available for those who would drive.

Freight movement between Louisville and Columbus is similarly hampered. By highway, the interstate is available. Air and water routes are lacking. Single-carrier rail service is available by two companies. The Department of Transportation's (DOT) reorganization[2] plan would have reduced rail service to a single carrier, but the United States Railway Association (USRA) *Preliminary System Plan*[3] (PSP) reversed that decision.

The random monopoly pattern of American ICT means that a situation analogous to that between Louisville and Columbus will frequently prevail, largely on a basis of historical accident.

The quality of ICT would seemingly improve in the larger states. There, the absence of federal regulation has made it easier for innovators to establish themselves.

While the line-haul ICT varies from very good to nonexistent, access to line-haul termini is part of urban transportation and suffers from all its defects. Moreover, internal urban transport needs dominate ICT; defects in the access system will not attract the same popular attention as defects in urban transport.

At airports, for example, it is easier to add ramp positions and/or bring widebodies into service than it is to increase curbside transfer length, or even parking facilities. Still more difficult is the increase of access capacity from streets and freeways. The latter difficulty is compounded by the organizational dichotomy between airport and highway management organizations.

In peak travel periods, lack of linear curbside space for discharging and loading, and/or lack of vehicle storage facilities, may bring the flow of traffic to an airport to a complete standstill. Subsequent radio appeals to travelers to leave their cars at home and to arrive by bus will be ineffective, even if heard, since bus movement will also be clogged. Moreover, intercity travelers are likely to be burdened with luggage and hence to be largely immobilized if the wheels stop turning.

Our asymmetric web of self-imposed restrictions produces an uneven impact in the various geographical markets for ICT. Broadly, innovators are excluded from ICT; monopoly and pricing by cartel are encouraged.

How We Got Here

We reached our present state in ICT not by careful planning but by historical accident. Chronometers, rails, and military organizations were known at the time steam power was applied to locomotion. The telegraph, the vulcanization of rubber, and portland cement remained to be invented.

In the 18th Century, we knew how to make smooth lines, the rails, but not smooth surfaces, the roads. Rails had industrial uses, especially in mines. But surface paving was rough cobblestones in urban areas, waterbound macadam in rural. Early steam carriages and locomotives were heavy and fragile. Lacking even solid rubber tire, on free-running surfaces, they shook themselves apart in short order. Primitive rail was, however, smooth enough to ensure the survival of the steam locomotive. During the three or four decades between the application of steam power to locomotion and the invention of portland cement and vulcanized rubber, the steam railway captured everyone's imagination, and railway construction took place of highway construction.

Early railways were thought to be merely substitutes for highways or at least turnpikes, and therefore, open to all vehicles willing to pay the tolls; but the inflexibility of the flanged wheel or rail to make passing maneuvers made it impossible for vehicles of many owners to move freely over railways without some form of centralized traffic control. Since the telegraph was an invention contemporaneous with cement and rubber, central traffic control before mid-century required the development of a fixed plan of movement with vehicles adhering to timetables and meeting at fixed times at the established turnouts. Watches and chronometers had been much earlier inventions. But once a vehicle was dispatched, there was no way to communicate with its operators. Worse, until the invention of the telegraph, there was not even any way to communicate with way stations or other dispatching centers. Thus, centralized and advanced planning was necessary, and that plan had to be imposed with discipline on the train operators. That requirement of discipline was accepted to mean that only trains of the organization could be permitted to operate. The idea of the railway as a form of highway open to all died.

The railway became the first large-scale civil operating organization. Large operating organizations had been military until then. Railways borrowed discipline and bureaucracy from that source.

The railway also became the first large-scale financial organization and the first major user of the corporate form of business organization, with its distinguishing characteristic of the limitation of liability for the stockholder.

Railway construction requires, of course, major capital investment. Construction has typically been in advance of demand; hence, railways have been marked by excess capacity. Typically, they were built to link major cities by alternative routes; hence, they competed for traffic between termini, but enjoyed a monopoly position for traffic at intermediate points. Substantially different price policies were applied depending on the competitive situation.

Since railways required so much capital, the construction of competitive railways did not often promise a payoff; when such a railway was constructed, it was not uncommon for the two competitors to merge. The discriminatory price policies adopted by the railways as a function of the competitive situation in each market was considered antisocial. In the later decades of the 19th Century, states and then the federal government established commissions to regulate and control the prices and services of the railways. Railway resistance led to many years of court tests and to further legislative action. The emergence of real power in the commissions coincided with the invention of the internal combustion engine and its application to transportation. Even so, the railway technology has shown considerable vitality, and more than half a century went by before major segments of the industry became clearly nonviable as private business enterprises.

The railway industry still follows a form of industrial organization based on the state of the art, both social and technical, of the early 19th Century. Its competitors evolved in the 20th Century and not unsurprisingly, have adopted 20th Century organizational forms. The rail industry might be strengthened if it would borrow from those forms.

"What if . . ."

If the historical sequence of technical inventions had been different, our present social organization of transport would be different. Suppose highway technologies had evolved before the application of steam power to locomotion, or alternatively, that such an application had never occurred.

Robert Fogel,[4] an econometrician, has played with the latter possibility. His crystal ball shows a greatly expanded use of internal waterways, but no significant difference in the long-term development of the country, or the level of its productivity.

Smooth surface highways would probably have been built to form a national web; inland waterways would have been more fully developed. Some form of railways would, no doubt, be built for their original purpose: the carriage of heavy commodities such as coal and ore.

Population and industrial locations clearly concentrate at transport nodes. The nodes, undoubtedly, would have been different, and the waterway junctions, and particularly transshipment points, would have been more important. Louisville, Cairo, and St. Louis would have become relatively more important; Chicago and Atlanta less so. The arid West would probably have been slower to develop; intercoastal shipping service, even without an isthmian canal, would have had greater growth. Large corporations would have appeared later on the social scene. The organization of water and highway transport would have been much more fractionated, much more the province of the individual entrepreneur. Highway transport would resemble the present owner-operator pattern; inland water transport would resemble the European barge operation, also individually owned. Pricing would have been competitive, and involved much bargaining and *ad hoc* negotiation. And finally, without the strong monopoly elements of the railways, there would have been no need for the regulatory commissions.

In summary, the railway technology in the 19th Century required the application of large-scale organizations to transport. If the sequence of inventories had differed by a few decades, the railway technology might have had a less enthusiastic reception, and monopoly might be less entrenched in our social organization of transport.

The New Technologies

The early 20th Century was a period of great technological innovation in transport. The internal combustion engine pushed highway transport to the fore; toward the third decade of the century air transport emerged as a dynamic industry.

The period from World War I to the 1930s saw the emergence of new and competitive transport technologies, and the strengthening of the regulatory commissions. The most important increment to the strength of the ICC was the addition of entry control in 1920. By this time, investment in new railroads had ended; but in any case, since the railway companies were showing financial weakness, ascribed to too much competition, additional competition in rail technology was prohibited. Awkwardly, since highway development was already making rail branch lines redundant, the 1920 law required commission approval not only for new lines, but also for abandonments, a situation the rails were to regret for more than half a century.

The 1930s saw the extension of the railroad monopoly philosophy to the new transport technologies. The highway system and airspace were

ubiquities. Capital requirements for vehicles were small. Possibilities were offered for tailor-made and competitive transport for persons and property between virtually all points. Nevertheless, the economic model of the railway as a "natural" monopoly was so strongly entrenched in our thinking that it was extended uncritically to the newer technologies. An especially serious limit on innovation in the new technologies was the imposition of entry controls, as in railway fashion. Established carriers received "grandfather" rights and protection from further competition; newcomers who might have thought of novel ways of conducting business were excluded.

In summary, railroads came in large units. Their competitive behavior was considered antisocial. After World War I, entry controls were adopted in the hopes of obtaining better utilization of the existing plant. In the Depression of the 1930s, entry controls were extended to the 20th Century technologies. Those controls hold innovators out of the industry. As outsiders, potential innovators have no voice in Congress and remain unrecognized. Only the established industry is heard, and the status quo is preserved.

A Review of Regulation and Its Effects

As we have seen in the concluding paragraph in the previous section, the invariant 19th Century business organization of the rails is encouraged by the regulatory structure that gives its attention to those established in the industry. Innovators are ineffective outsiders, even though their voices may be heard in the analyses of regulation.

First, consider some past studies of regulation which have generally followed one of two tracks: the economic aspects of transport regulation--cartel pricing, umbrella rates, and the resulting misallocation of resources--or the procedural and organizational problems of the regulatory agencies--relations vis-a-vis the industry and the public; national transportation policy determination, or lack thereof; and problems of implementation.*

The economically oriented studies have fairly adequately established that regulation has resulted in misallocations of resources in the ICT industry, which cost consumers money since costs of transportation are higher than in a truly competitive market. A few studies have attempted to measure these costs: airline trunk fares were estimated 20% to 95% higher than they should have been in 1965 and between 45% and 84% higher

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*A bibliography of the major post-World War II studies is given at the end of this paper and includes brief descriptions of the major recommendations of each study.

in 1972;[5] ICC regulation was found to have resulted in average annual excess costs from $3.775 billion to $8.790 billion in recent years;[6] another source estimated their costs on freight traffic only at $2 billion to $5 billion annually.[7]

Most studies have also acknowledged that there are other costs of regulation imposed on our society, which elude quantification and are of a more psychological or moral nature. What is argued here is that regulation eliminates all meaningful incentives to innovate and so demoralizes the ICT industry that it tends to fight innovation whenever and wherever it occurs.

This disinterest in innovation, despite a note of concern in past reports on regulation, has been given little explicit recognition, one reason being, perhaps, the intangible and immeasurable loss to society of uncreated or even unadopted innovations. There are not wholly competitive intercity transport industries in other postindustrial nations with which to compare, and there are interactive effects which preclude a simple comparison between a small unregulated sector of the industry and the regulated sector; such a comparison, if possible, would not be simple to evaluate. Innovation can take many forms, and the forms of its regulatory frustrations are likewise diverse.

Consider the source of innovation. Innovation is usually expected to come from those within the industry who presumably know the most about its needs, who have the most information about the potential payoff of innovations and usually are the beneficiaries. Of course, there are frequent short-term discentives, such as fixed investments, that might discourage some innovations, but if the payoff is significant, there will probably be someone willing to adopt an innovation.

The contention here is that regulation has turned this situation inside out in the transportation industry. First, the most effective stimulation for innovation is the clear perception of market forces. Regulatory policies and practices have, however, severely distorted the operation of ICT market forces. Many potential innovators are outsiders. They usually do not have as much information as insiders, and so are less motivated and fewer in number than in a truly competitive industry; but there is minimal incentive for outside innovators, since the industry is usually not interested in purchasing an innovation, because there is no incentive to do so. So, the only way to introduce an innovation to the industry is for the outside innovator to become a member of the industry, which is exactly what the regulatory agencies have been best at discouraging.

A recent study concluded, not surprisingly, that there is more effective stimulation for innovation than a clearly perceived market "pull." To be effective, this "pull" must be allowed to be expressed in terms

that the private sector can use to determine fairly accurately the risk/payoff potential. A poll conducted as part of the study indicated that uncertainty about future rulings and federal regulatory policies was a critical factor in evaluation procedures.[8] While this study was not concerned with the traditionally regulated industries, an analogy would seem to be appropriate.

Congress has never required firm statements of policy either of itself or of the regulatory agencies,[9] and it is doubtful that regulatory agency appointees have the qualifications or interest to establish policies. Indeed, it is not always clear that regulatory agencies are even aware of the policy implications of many of their decisions. On the other hand, it is unrealistic to expect Congress to establish policy edicts; there are simply too many diverse interests in Congress. It is easier to agree to do something (spend money on a project or program) than to agree on why it is being done. The lack of clearly enunciated policy maximizes the uncertainty associated with the outcome of any regulatory proceeding.

In regulatory matters, the tendency of the agencies is to move on beaten paths. Balancing decision making to avoid the appearance of favoritism seems to predominate over maintaining consistent judgment criteria. Congress is no more consistent in its reviews of the regulators' activities. The result is that chance predominates, which hardly reassures anyone.

Inordinate delay characterizes the disposition of proceedings before the Interstate Commerce Commission, the Civil Aeronautics Board, and most other regulatory agencies. In the CAB, the average age of dockets closed by formal proceedings in 1962 was 32 months. On June 30, 1959, of 464 proceedings then pending, 166 had been so over three years. Contested proceedings before the ICC at that time consumed between 18 and 36 months.[10] The Rock Island merger case was before the ICC for 11 years without a decision. It is doubtful that these averages have changed appreciably. Uncertainty increases over time, making a current innovation less attractive. In addition, the value of an innovation is considerably reduced if it cannot be made to pay off for three years or more. Of course, not all innovations require regulatory proceedings, but regulatory involvement in the industry is pervasive enough that the threat extends to practically all horizons.

In general, then, the framework of the present regulatory system has preserved the status quo.[11] Regulatory decisions are not based on any established principles; chance seems to play a great role in agency considerations; and excessive delays characterize the performance of the agencies, all of which militate against the objective of a dynamic, innovative ICT industry.

Within the ICT industry the disincentives for innovation are most closely associated with rate regulations, although the common-carrier

concept has some effect also. Regulatory agencies have encouraged the formation and maintenance of regional rate bureaus. All carriers in each mode serving a region are encouraged (coerced? persuaded?) to join the bureau and to determine regional rates. The necessity of agreement on a common set of rates is undoubtedly a dampening influence on innovation.[12] In a competitive industry this would be known as illegal collusion and price fixing; being that such competition is destructive.

Carriers, then, using the rate bureaus, have attempted to devise rates that will maximize their profits. Each of these small cartels is, however, to some extent in competition. A considerable amount of adversary maneuvering is thus encouraged in the regulatory agency's review of rates. Carriers will attempt, for example, to minimize the information supplied to the agency for fear of its competitive use by other carriers. Given their endemic lack of expertise and resources, the regulators, not surprisingly, exhibit a willingness to accept a passive review function.[13] Lacking adequate information, they reject most innovations because of inability to predict impact. It has been suggested that perhaps an even more fundamental problem of the regulatory process is that it diverts a management's attention from consideration of opportunities to serve transportation needs to the rather parochial concern of how to divide up existing traffic.[14] The systematic needs of shippers and travelers, which could offer opportunities for increased profit, are largely ignored.

The primary goal of the regulatory agency is, then, to maintain the balance of power between adversaries by ensuring that rate changes do not upset the prevailing market shares of each mode.[15] Any sweeping innovation is probably self-defeating for the carrier, as its costs might well bankrupt it before any payoff could be realized. Simple cost-saving innovations are an exception, and not surprisingly, most have been of this type, for instance, the diesel-electric locomotive and automatic crossing gates.[16]

Rate flexibility is necessary to allow the innovative carrier to reap some benefit. Regulation, by inhibiting (and practically prohibiting) rate flexibility, denies to the ICT industry the temporarily large profits that are the inducement to innovation in a competitive market. Carriers have no incentive when they know that they cannot gain anything from innovation; this is not a case of holding out for unjustified returns but simply a fair market return when due. The result of this impediment to innovation is that the ICT firms tend to supply transportation of lower quality and at higher rates than would otherwise be true.[17]

Another factor that contributes to the destruction of incentive within the industry is the common-carrier concept. Most regulated carriers are common carriers and must transport cargo tendered by shippers so

long as it is in the proper form (packaging, etc.). That requires maintenance of excess capacity to serve all potential customers. The common carriers may be the "carrier of last resort" for many shippers or travelers.[18] Investment in excess capacity adds considerably to the cost of adopting any technological innovation, the result being that an innovation is not adopted unless the payoff is so great that it makes up for its underutilization. In addition, if the carrier is financially unstable, additional required capital may prove an impossible burden; the British recognized this some years ago and abandoned the standby capacity concept.

Regulation has created innumerable anomalous situations for carriers within the industry. For example, in 1958, unit-train rates (as distinguished from individual-car rates) for shipping coal to the Northeast would have produced considerable additional profits for the railroads, but the divisions were not distributed to net each carrier some additional profits. Some might have incurred temporary losses. That would not have mattered in a competitive industry, but the potential losers were able to prevent the adoption of the rates for four years, by which time no railroads were apparently going to come out on the short end, and the rates were finally approved. The rate bureau system and rate regulation made this situation possible.[19]

MacCallum has examined a number of proposed multiple-car rate cases. The general evidence is that multiple-car shipments cost the railroad less than shipments by the traditional unit, the single car. That is because the cars can be handled in a block. Thus, fewer switching movements are required. The limit of the multiple-car shipment is, of course, the unit train. MacCallum estimates that ICC reluctance to move away from the traditional single-car load as the pricing unit may have cost the railroads $4 million to $18 million in the five years 1958 to 1962.[20]

The common-carrier concept has also contributed to this situation. For instance, a regulated motor carrier wished to use a collapsible rubber tank, developed to aid in the transport of dry, flowable commodities, which offered the opportunity of increased efficiency, particularly no expensive return haul of a bulky empty tank. It was ruled, however, that common carriers could take advantage of this innovation only if the tanks were filled and then loaded on the truck, a practical impossibility; otherwise they could only be used by nonregulated contract carriers.[21]

The piggyback idea has existed since early in the century; however, not until 1931 did a railroad attempt to apply it. But, the ICC failed to approve the rate application until 1936, at the depth of the Depression, at which time the railroads were desperate.[22] There are five different rate schedules for piggyback service depending on who solicits the traffic, supplies the cars and trailers, and performs the road delivery. Rate Plans III and IV are unusual because they are flat rates. (Most

transportation rates are of the value-of-service type.) These two special rates were developed for freight forwarders; however, the ICC made them available to any shipper. Undoubtedly, these rates would have attracted considerable new traffic; however, the railroads saw them as a dire threat to their complex price discrimination rate system; they fought them all the way to the Supreme Court.[23]

There is, then, considerable evidence to support the conclusion that federal regulation has aggravated and compounded inherent differences between transport modes, denied reasonable rate flexibility to all modes, and encouraged the maintenance of excess capacity. Not surprisingly, the ICT industry is suffering from an acute case of institutionalized frustration. What is lacking is the "courage to abandon the safety of protection and the privilege of inefficiency,"[24] or in other words, the desire to be innovative.

If innovation is not to come from within, then how about from without? It is reasonable to expect that "outsiders" could develop innovations applicable to the ICT industry, especially given the low rate of internal innovation. There is a considerable amount of intercity transportation performed by unregulated carriers of various types. One would expect them to be at least moderately innovative, since they are subject to competitive forces, and they are innovative.

The unregulated sector includes no railroads or petroleum pipelines, no highway passenger carriers, approximately 60% of the highway freight carriage (ton-miles), and about 90% of the inland waterways carriage. Intrastate airlines are typically regulated in a lenient fashion by their states. Even in the modes where the unregulated sector is large, its product mix is fairly severely limited. In inland waterways, the mix is limited to three bulk-commodities per "tow," or wet of barges. Large volumes of single bulk-commodities are thus required. In highway freight, there is a considerable amount of private transportation; the shipper owns and operates his own vehicles solely for his own requirements.

There are the "gray areas," including carriers of commodities, notably farm products, that are specifically exempted from regulated common carriage and a class known as "contract carriers" whose definition is even less clear. Where these unregulated carriers directly compete with regulated carriers, they have clearly been far more innovative; they supply better services at lower rates.[25] In fact, they are so successful that considerable amounts of the most desirable traffic have been attracted to private and professional *unregulated* carriage, wherever it is allowed and, probably, a few cases where it is not.

Regulated carriers have consequently been left with the less desirable traffic, the rates on which have been held low by the regulation, and with considerable investment in excess capacity: a misallocation of resources caused by the regulatory system.[26] There are two readily

apparent ways of redressing this competitive imbalance: subject all carriers to regulation, or entirely eliminate regulation of the ICT industry.[27]

The ICC and CAB have, of course, advocated the extension of their regulatory powers, so that all of the disruptive (read innovative) elements of the industry can be brought into line. The railroads, with nothing to lose and much (perhaps) to gain, also consistently advocated regulatory extension, having originally proposed the National Transportation Policy statement, which establishes regulation as a national goal, in the Transportation Act of 1940.[28]

In their dealings with outsiders, the regulatory agencies favor the protection of the existing regulated carriers rather than the future of innovation for the shipping and traveling public.[29] For instance, the offering of more efficient and faster service, more responsive to the needs of shippers, by an outsider desiring to enter the industry is considered by the ICC to be irrelevant to its decision.[30] CAB route award policy is extremely erratic or nonexistent. Neither efficiency or any other argument for certification[31] has been consistently accepted. It appears that if the agency can find an argument, no matter how unreasonable, to deny entrance to the industry to a potential innovator, it will be used.

This control over entry is a very effective barrier to the introduction of innovation from outside the industry. It can even impede innovation elsewhere in the economy since transportation is an intermediate service. For instance, the concentration and freezing of juice from Florida oranges offered the potential of great transportation savings: elimination of water reduced weight. The growth of this innovative new process was, however, severely hampered by the reluctance of the ICC to certify new refrigerated-service carriers.

In general, the regulatory agency petitioner must be well supplied with funds and willing to wager them on his chances of ultimately being successful. The result is that small businessmen are practically excluded,[32] and that means many fewer potential innovators. All available evidence seems, then, to indicate that regulation has resulted in worse conditions with respect to innovation than would otherwise obtain.[33]

Deregulation in varying forms and to varying degrees has been proposed in each recent administration. Congress has made no more than nominal changes. Meantime, the rail industry is collapsing.

The following sections outline the steps by which ConRail will be organized in 1976, and point out ways by which the bankrupt rail industry, and perhaps the whole rail industry, could adapt to 20th Century organization.

Death of the 19th Century Rail System

The latter half of the 20th Century has seen the decay of the private enterprise rail system with its 19th Century form of business organization. Labor and material shortages during World War II gave the rails a reprieve, but the postwar decades saw the progressive decline and collapse of the U.S. rail system. In 1975, the bankrupt railways extend as far west as Denver. New York, Newark, and Boston, for example, are accessible only by bankrupt rail carriers.

Historically, bankrupt railroads could be reorganized by scaling down the capital structure; that is, operating results were positive. The rail bankruptcies of the 1970s are, however, characterized by negative cash flow at the operating level; with present business practices, reorganization is not possible even if capital charges are reduced to zero. Thus, revenue must be increased and/or costs reduced if the bankrupt railways are to survive as private business enterprises. Raising revenue is, however, difficult: higher prices are driving traffic to the newer competition, and the quality of rail service is deteriorating.

One key to further cost reductions lies in the restoration of track conditions to a quality that will permit train movements at the speeds which were common a generation ago. That would improve the productivity of both labor and capital. Another key lies in agreements for train manning.* The bankrupt railways have, however, been operating with frequent infusions of federal funds; as long as Congress is willing to support crews of the present size, the unions have no reason to negotiate for lower manning scales.

The bankrupt railways have suffered from massive undermaintenance. Rails and ties have lives of some two decades. Under generally acceptable accounting practices, their replacement would be an investment to be depreciated over their estimated useful lives. Railways operate under ICC rules, however, and ICC accounting provides that rail and tie

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*Present rules require men on each train: engineer and head-end brakeman on the locomotive and conductor and rear-end brakemen in the caboose. The Florida East Coast, the only railway not a party to the union agreement, operates with crews of two men--engineer and conductor in the locomotive. The rear of the train is marked by a radio beacon tuned to a receiver in the locomotive according to the length of the train. A change in the distance between rear beacon and locomotive receiver notifies the engineer if the train has separated. Extra switching movements of the caboose are thus avoided, and yard expense is reduced.

replacement is an expense. Management thus uses track work as a tax haven, performing it in profitable years when tax liabilities threaten and deferring it in unprofitable years. Since the bankrupt railroads lack profitable years, tracks are rarely maintained. The result is slow train speeds. A train crew cannot, for example, make its run from terminal to terminal during the maximum period of consecutive work permitted by the ICC. Thus, after 16 hours the train must stop, report, and wait until a relief crew is brought by taxi, which expensively returns the exhausted crew to its base. Cincinnati to Columbus and return was, for example, a day's work for a crew. It is now a day's work for three crews. Since there are fixed coefficients between labor and capital, the productivity of both labor and capital is drastically reduced by the poor state of the track.

The USRA's *Final System Plan* calls for bringing 6,300 miles of branch line up to conditions to sustain 10 mph;[34] that speed is the speed for minimum track conditions under Federal Railroad Administration safety standards.[35]

The decay of the railway physical plant has reduced the productivity of both labor and capital. Slow and unreliable service has alienated shippers. Only the largest shippers have been able to develop their own unit trains. Smaller shippers are pushed to develop their own transport on the highways, so furthering the decay of the rails.

Some Current Policy Options

Outside the United States, rails were developed during the 19th Century as private enterprises in some countries and in other countries as government undertakings. Sometimes, as in France, arrangements were mixed. The government built the lines and then leased them to qualified private enterprises for operation.

By the late 19th Century, there was a continuing shift throughout the world from private enterprise railways to government-owned and -operated systems. The mechanism was almost always the same: the private enterprise fell into financial difficulties; continuation of the service was considered essential. By the end of World War II, the Canadian Pacific remained the only significant nongovernment railway outside the U.S.

Railway systems abroad had been governmentalized before 20th Century traffic control techniques were well developed and widely used. Governments took over the railways with their 19th Century management organizations intact.

It is only in the U.S. that governmental acquisition of the railways has been delayed until the late 20th Century, and hence, that acquisition is reluctant, tentative, and disguised as an interim arrangement

pending the restoration of profitable private enterprises. It is not surprising that this reluctant and temporary acquisition is carried out according to well-established ideologies.

This section reviews the present plans and forecasts. Then the next section indicates a possible new method of railway organization. The latter would be based on the organization of other 20th Century transport technologies and would employ 20th Century communication methods. The alternative may offer the possibilities of increased utilization of the rail technology, decreased governmental subsidy requirements, the encouragement of innovation, and the reduction of regulation.

At present, the major bankrupt carriers are the Boston & Main, Penn Central, Central of New Jersey, Reading, Lehigh & Hudson River, Erie Lackawanna, Lehigh Valley, Ann Arbor, and Chicago Rock Island & Pacific. The area served primarily by bankrupts extends along the Atlantic Coast from Portland to Norfolk; generally north of the Ohio River. The northern edge of this territory includes Montreal, Mackinaw City, Twin Cities, and Sioux Falls. Denver, Colorado Springs, and Tucumcari describe the western border, and Galveston and Memphis the southern.*

It is useful to look at the bankrupts as a system, since only with them are significant changes in structure and organization currently possible. Present institutional arrangements, as embodied in the Regional Rail Reorganization Act of 1973, look upon the eastern bankrupts as a possible system.

The Penn Central (PC) is the major bankrupt, and in the five years since its collapse, there has been time for considerable investigation and legislation. Initially, it had been supposed that reorganization could occur in the usual way. Only recently has the need for more imaginative treatment become clear. Even so, most solutions are still based on the accepted pattern of rail operation during the last century and a half.

The Rock Island (RI) bankruptcy occurred only in 1975, and a different treatment is being proposed for it. This line was recognized as a nonviable independent railway more than 11 years ago;[37] plans were made to merge the line into adjacent railroads. Those plans usually involved

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*A study by Altman[36] attempts to forecast bankruptcies, and most of the above lines were selected in advance by the model, which also selected Western Pacific. While that company is presently operating at a loss, it is still solvent. Should the model be correct, the bankrupt system would extend to San Francisco, with a solvent gap between Denver and Salt Lake.

dismemberment, with RI routes being assigned to a number of carriers. The ICC did not act decisively during those 11 years; then the RI collapsed, and the problem is now one of maintaining any service at all over its lines.

In the five years since the Penn Central collapse, Congress has enacted the Regional Rail Reorganization Act of 1973 (Public Law 93-236, 87 Stat. 986), but Illinois is westernmost of the states included in the statutory definition of the region. Since Illinois is the easternmost state served by RI, it is difficult to include the RI in the Act's concerns.

The underlying ideas of the Act are ascribed to the legal department of the Union Pacific Corporation, one of whose major holdings is the Union Pacific Railroad.[38] In its final form, the Act seems to have been drafted to obtain as many inputs as possible. A detailed timetable of reports was provided, as follows:

February 1, 1974	Report by U.S. Department of Transportation, *Rail Service in the Midwest and Northeast Region.*
May 2, 1974	Evaluation of that DOT report by the newly established Railway Services Planning Office (RSPO) of the Interstate Commerce Commission.
February 26, 1975	USRA *Preliminary System Plan* (PSP).
April 27, 1975	RSPO Evaluation of USRA's PSP based on public hearings beginning March 17, 1975.
July 25, 1975	USRA *Final System Plan* (FSP).
August 25, 1975	ICC Evaluation of FSP.
November 9, 1975	Probable date before which Congress must have disapproved FSP.
February 27, 1976	ConRail will commence operations.[39]

The USRA *Final System Plan* became final since Congress did not disapprove. (In the event of disapproval, the USRA would have returned to square one and prepared a revised final plan in cooperation with the DOT and the RSPO of the ICC.) Until ConRail commences operation, the USRA can commit federal funds to the support of regional rail lines.

The Act authorized the USRA to establish a for-profit Consolidated Rail Corporation in Philadelphia (ConRail) to take over the operation of the bankrupt eastern lines in accordance with the Final Plan. The equity

in ConRail is to be held by the estates of the bankrupt lines, but the majority of the Board of Directors is to be federally appointed as long as the majority of the debt is federally held. Until ConRail is established, abandonments are prohibited, but rail service continuation subsidies are authorized. Employees are protected if the operation of the Act deprives them of employment.

The above sequential reports represented a serious attempt to evaluate the rail system and to develop a model of rail operations, but the underlying form of business operation was never questioned, that is, a single operating organization. The DOT report quantified the flow of traffic, developed its nodular concept of railway operation, and contemplated the abandonment of a substantial amount of branch line, particularly in Ohio, Indiana, and Michigan. A common pattern was that cities were to have one line leading out to a main route, the hypothesis being that traffic carried by rail is not time-essential traffic, and that circuitry will not be critical in its retention on the rails.

USRA *Preliminary System Plan*. The USRA *Preliminary System Plan* was largely based on reports of private consultants. It proposed somewhat less rail line abandonment than did the DOT.

In the latter stages of the Plan's preparation, the Erie Lackawanna (EL) abandoned hope for an income reorganization under Sec. 77 and asked for inclusion in the USRA Plan. At that time, USRA could only suggest a tentative plan for its inclusion: hope that a solvent road would acquire EL east of Buffalo. That would offer New York City both ConRail and a private-line service. If EL were reacquired by the Norfolk and Western (N&W), a solvent line, the latter would be permitted to connect directly with an affiliate, Delaware & Hudson (D&H), which, in turn, connects with the Boston & Maine (B&M) (in Sec. 77, bankruptcy). Competitive service could also be provided to Boston. In addition, if B&M were successfully reorganized, a private route would be available to compete with ConRail.

The Chessie System, a solvent line operating into Philadelphia over a single track, was planned to obtain some of the Reading (RDG) lines in southeastern Pennsylvania, but the old B&O route into New York over the Central Railroad Company of New Jersey (CNJ) would not be preserved. Finally, CNJ would become part of ConRail and New York City would be left with, at best, two carriers.

If the solvent carriers were unwilling to embroil themselves in the East Coast terminal problem, USRA recommended the formation of two competing government lines: MARC-EL (Middle Atlantic Rail Corporation plus the Erie Lackawanna) and ConRail. MARC-EL would consist of the EL plus CNJ, RDG, and Lehigh Valley Railroad (LV) lines, which would give MARC-EL access to most major terminal cities in northern Delaware, eastern Pennsylvania, northern New Jersey, and New York. Competitive service to Boston would be maintained over D&H-B&M connections. EL's western connections are limited; presently only Cincinnati and Chicago

are the major junctions. USRA also contemplates a rationalization of routes west of Mansfield, Ohio, and EL and ConRail having trackage routes over the better lines to at least Cincinnati, St. Louis, and Chicago.

A number of other alternatives were considered and rejected, the most important being a separation of ConRail into east and west (thus making a separate company of the complicated eastern terminals) and north and south (essentially a demerger of Penn Central into the old New York Central and Pennsylvania). Also rejected was the establishment of a Consolidated Facilities Corporation (ConFac), which would own the right-of-way used by ConRail. The ConFac concept was not explored in any detail; USRA stated that too many questions remained to be resolved before any type of recommendation could be made.[40]

In the Northeast Corridor, it was recommended that the present PC line between Boston and Washington be acquired by AMTRAK, the National Railroad Passenger Corporation, on the supposition that freight traffic between Boston and Washington would move via the B&M, D&H, LV, and RDG to connect with the Chessie System in Philadelphia. That would separate freight and passenger service completely and rid ConRail of some of its most difficult terminal operations, although generating circuitry and some capacity problems. The old B&O line from Philadelphia to Washington, formerly double-tracked, has been reduced to single line; if competitive western traffic to southern Pennsylvania together with all freight traffic between the south and New England were to be routed over the old B&O line, then double-track operation would presumably have to be restored by private enterprise.

USRA projects that with two private systems (N&W over EL into New York AMTRAK and New England; Chessie into Philadelphia) and passenger traffic in the Northeast Corridor shifted to AMTRAK (i.e., another government budgetary item), ConRail could become profitable by 1978.

Fishwick's Proposal. The Railway Services Planning Office (RSPO) of the ICC (established by the Regional Rail Reorganization Act, which provided an initial input into USRA planning by commenting briefly on the DOT's first study)[41] held hearings in over 20 locations during March 1975. Approximately 1,900 witnesses were heard,[42] one of the most impressive being John P. Fishwick, President of the N&W, one of the two major solvent railroads in the region. Fishwick had been pushing for a general solution to the northeastern railroad problem since 1970, but he had been unable to make his ideas effective.[43]

Fishwick argued that the USRA's ConRail plan did not provide a private sector solution to the northeast rail problem, that USRA's financial projections were too optimistic, and that the solvent railroads cannot compete with ConRail's governmental financial support and commitment. He proposed that the bankrupt lines be divided on an east-west basis, which was one of the possibilities considered by USRA. ConFac would purchase the eastern lines, east of Harrisburg and Albany, so providing

a conventionally reorganized PC with funds to rehabilitate lines west of Harrisburg and Albany. ConFac would then sell off the passenger lines: the Boston-Washington corridor to AMTRAK and the commuter lines to local transit districts or authorities, most of which are already established. The solvent roads would then be provided with extensive new trackage rights over ConFac and PC, and thus access to the eastern terminal cities.

Since N&W does not presently reach the northeastern cities, Fishwick proposed that his road be given trackage rights over PC from Orrville to Harrisburg, and/or over EL or LV east of Buffalo. In addition, to the Washington-New York range of cities, the plan would provide N&W a connection to D&H at Scranton or Wilkes-Barre, and hence access to Boston via B&M. Fishwick does not suggest trackage rights to Boston, but N&W already has financial control over D&H. N&W's present eastern termini are Buffalo, Connellsville, Hagerstown, and Norfolk. Hagerstown would be the terminal closest to the proposed ConFac. In summary, Fishwick believed that PC could operate profitably west of Albany and Harrisburg, and hence could be reorganized on an income basis, as evidenced by N&W and Chessie's profitable operation in that same territory.[44]

Fishwick also attacked USRA's financial projections. Government debt holding, he argued, will dominate the capital structure into the 21st Century, so leaving the government in control. He did not, in addition, accept the forecasts of traffic growth, pointing out that PC has had none over the last five years, and that the growth in coal traffic, on which the USRA projections heavily rely, is not taking place in PC territory, but in the West. Moreover, USRA estimates assume that PC can attain the operating ratios of N&W, Southern, Chessie, or Union Pacific, which are among the lowest of the major railroads. Finally, he argues that PC's traffic mix and operating conditions are not nearly as favorable as those of the above four lines, and he doubts that anything like that ratio can be obtained with operations in the Northeast megalopolis.

In a publication distributed by the Union Pacific Railroad, the ConFac proposal was strongly opposed by the Association of American Railroads (AAR).[45]

RSPO Evaluation of the USRA Plan. Given such testimony, it is not surprising that the RSPO's evaluation of the USRA Plan was hostile, e.g., "We agree that it was *preliminary* but we must question whether it is a plan."[46]

The RSPO evaluation rejects the USRA's three-carrier system (ConRail, N&W, and Chessie) in favor of a four-carrier system. In the latter, ConRail would become two by the establishment of MARC-EL, to include EL, LV, RDG, CNJ, and Lehigh and Hudson River (L&HR). The other bankrupts would go into ConRail. MARC-EL would extend west to Cleveland, although its principal connections would be at Buffalo, served by N&W and Canadian lines, as well as a branch of Chessie.[47] The RSPO also notes that, "The Final System Plan should provide for the joint use of

rail facilities wherever this would be feasible and cost-effective."[48] Thus, RSPO arranged itself on the side of Fishwick for ConFac, opposing the AAR lead by the Union Pacific.

The RSPO recommends, in addition, deferral of any light-density-line abandonment pending another two years of study and data accumulation, relying meantime on the subsidy provided in the Act, which the RSPO finds ample. Some lines would then be acquired by ConRail, others would be acquired by the states and operated with matching federal subsidies.[49] The substantial federal expenditures for the RSPO program would be offset by an energy tax, 2 cents per gallon of fuel or 0.14 cents per kilowatt-hour imposed on all domestic transport except buses.

Despite its support of ConFac, the RSPO proposal was not well received in the private enterprise sector. The *Wall Street Journal* editorialized that the ICC plan "is heading towards a fully subsidized inefficient Northeast rail system that no doubt would eventually end up with the government in control. In the process it would weaken healthy private carriers, which no doubt would eventually make them eligible for an ICC rescue plan as well. The cut at the electric utilities seems to be gratuitous, perhaps with the notion of speeding up their eventual collapse. In other words, the ICC has devised an excellent plan for killing a number of birds, or a number of private industries, with one stone. Few other agencies, even in Washington, could have been so skillful."[50]

In May 1975, the DOT released the Administration's railroad plan, calling for a very substantial weakening of ICC rate control powers, direct federal lending to the railroads,[51] activation of the USRA version of ConRail on a temporary basis, and finally, a sell-off perhaps two years later, of pieces of ConRail to the solvent lines.[52] At the same time, the Milwaukee Road, a Western line running from the Ohio River to Puget Sound, signed a letter of intent to acquire leased lines from the PC as far east as Pittsburg.[53] That company had earlier been reported seeking trackage rights into Buffalo, presumably over PC.

USRA *Final System Plan*. The USRA's *Final System Plan* presented some modifications from the PSP. Fishwick's testimony before the ICC was essentially ignored, and the N&W participated only modestly in the FSP. N&W is offered trackage rights into Harrisburg from the southwest, and D&H is offered trackage rights into Harrisburg from the northeast, so restoring the connection between those two roads which had been lost when EL went backrupt at the beginning of the decade. Those rights give N&W access to New England via the B&M, but not the access to New York, Philadelphia, Baltimore, and Washington that Fishwick had proposed. N&W would also acquire a link northwest from Cincinnati, so shortening its route between the Mississippi and the Chesapeake.

The FSP reiterated the proposal that the present main passenger route between Boston and Washington be acquired by AMTRAK. ConRail would acquire from Chessie its single-track line between Philadelphia and Baltimore. Only local freight service would then be operated along the present passenger route. Chessie, on the other hand, would acquire major new routes in the East. From the present system, access to Philadelphia and New York would be through Harrisburg over present RDG routes, instead of through Baltimore. EL routes would be acquired east of Akron, Cleveland, and Buffalo, so giving Chessie routes into major upstate New York cities, as well as a more direct route into New York City.

There would be substantial abandonment of PC and LV lines: some routes in northern Michigan, most of those in West Virginia and the Delmarva Peninsula. The central network has also been considerably thinned. The Delmarva service is offered to the Southern Railway (SR). Out-of-gauge loads would then reach the Delaware, but otherwise this route would seem to do little to improve SR's traffic connections. In the PSP, Delmarva service was slated for abandonment.

The major difference between the PSP and the FSP lies in the role of the N&W. The PSP hoped that the N&W would reacquire the EL lines from Cleveland and Buffalo into New York. EL had been part of the N&W system prior to its bankruptcy at the beginning of the 1970s. But N&W had taken over EL only reluctantly, under pressure from the ICC after merger with the Wabash and Nickel Plate had been approved. N&W is apparently unwilling to take responsibility for its own terminals in the difficult New York and Philadelphia areas. When its suggestions for a ConFac east of Harrisburg were not accepted, it preferred to keep out of those markets. Thus, there is two-carrier service to the terminal area from Boston to Baltimore. ConRail will serve this entire area. Boston and Providence will have the B&M and its connections, principally the D&H and, hence, the N&W; the other cities will have Chessie.

Financial Plans for ConRail. Given the continuing physical deterioration of the Eastern bankrupts, USRA has had to plan for massive rehabilitation expenditures, many of the main lines of PC, L&HR, and a bit of LV being assigned first priority. First priority rehabilitation is defined as permitting freight train speeds of 60 mph. Rehabilitation is also planned for nine major yards and three industrial yards, plus the construction of a new trailer-on-flat-car (TOFC) yard. Second priority rehabilitation is proposed for other main lines, bringing them to standards defined only as "desired." With ConRail, 5,600 miles of line will get normal maintenance, but no rehabilitation, thus preserving those lines at the "desired" level; 6,300 miles will receive interim maintenance intended to permit operation at 10 mph; 2,000 miles will receive no maintenance;[54] 5,757 miles are recommended for abandonment or continuation with local subsidy.[55]

Maintenance-of-way expense is forecast at $317 million in 1976, rising to $679 million by 1985,[56] based on depreciation accounting, straight-lining the depreciation on track and equipment assets at 3.33% to 6.67% per year.[57] ICC betterment accounting, which essentially treats investment as expense, would increase maintenance-of-way expense to $449 million in 1976, rising to $1,001 million by 1985.[58] Cash requirements would be invariant regardless of accounting technique, but the chosen depreciation method will give higher net income figures,[59] so creating a deferred tax expense.[60] The higher earnings generated by generally accepted accounting principles should, however, result in higher market values for the Series B preferred stock and the common stock, and so minimize the Treasury's liability on the certificates of value.[61]

The capital structure will consist of debentures and Series A preferred stock to be held by the government; Series B preferred stock, common stock, and certificates of value will be distributed to the estates of the bankrupt railroads as payment. Since the bankrupt railroads have no earning power and cannot be reorganized on an income basis, USRA is essentially valuing them at salvage value minus the liabilities, such as labor agreements, which ConRail will be assuming. A public market may develop in the securities distributed to the estates of the bankrupts.

If ConRail does well, the stocks will be valuable and the certificates of value less so. If ConRail does badly, these certificates will increase in value. Their basic redemption value rises at 8% compound per annum; redemption will be no later than 1987. Investors who buy such certificates on the open market will be speculating against the success of ConRail.

Hilton[62] and Conant[63] join Fishwick in doubting ConRail's chances of success. Hilton notes the analogy with AMTRAK, and the dominance in a quasi-public corporation of politics over economics. Conant notes the failure to abandon enough lightly trafficked lines and to offer multicarrier service over single lines through the use of trackage rights, a ConFac equivalent. Those doubts are widespread throughout the railway industry. At the American Enterprise Institute's conference on Federal Transportation Policy in 1974, similar doubts were expressed by Tellison[64] and McAdams.[65]

Perhaps the certificates of value, which represent 8% Treasury debt, might maintain market prices close to redemption value. Unfortunately, the USRA's ideas for ConRail marketing reflect railroad tradition: raise the price and reduce the service.[66]

Thus, at the end of 1975, the FSP was well on the road to becoming effective. Congress had not objected. After some successful prior haggling, Chessie had agreed to take over EL on the same scrap-value basis as ConRail is acquiring its properties and subject to the federal

assumption of any liabilities which the bankrupt estates might have. ConRail had begun to bring together its new management team in Philadelphia.

ConRail represents a conservative 19th Century solution to the Northeast railroad problem. No change in industrial organization will take place; the 19th Century monopoly concept will be reinforced by the reduction in the number of carriers. An opportunity to apply to the railway industry a 20th Century industrial organization analogous to that of the other transport technologies has been missed. It may not be lost forever if the Administration has its way, and the ConRail organization is reviewed after a couple of years. But meantime, the vested interests in the status quo will be reinforced, and the probability of restructuring must be assessed as low. Conservatism, and even nostalgia, predominated and at federal expense.

20th Century Organization Applied to the Rail Technology. It is time to consider the alternatives to the 19th Century railway organization which are offered by the communication technologies of the 20th Century, and which have been adopted by all the other means of transport. This section explains the way in which railways might be organized as public highways with many carriers using a common track.[67] That is the pattern of transport by air, highway, and water. The USRA has called it ConFac.

If multiple carriers were possible by all transport technologies, then the maintenance of monopolies by the certificate of public convenience and necessity would become tautological. It would be apparent that the certificate protects only the monopolist, since alternative entry would be free in all markets, and all shippers could be served if they were willing to pay market prices. A private sector solution could emerge.

Rail technology has been the big stumbling block in most deregulation proposals. The political objection to deregulation has been that there may be a shipper who has no alternative to rail service; he is then gouged in the 19th Century fashion by the rail company; regulation prevents such gougings. If there were free entry, however, innovators would actively seek the shipper's business. At worst, the shipper could lease his own train. Privately owned unit trains serving power companies and international grain merchants are a long step in that direction.

Here is one model of how free entry might work in the rail business. The track would be a public turnpike. Trackage rights would be available to anyone paying the toll. The organization owning and maintaining the track (or contracting for its maintenance) might run trains, but other organizations or individuals would also run trains and pay tolls.

Obviously, in the present context of bankrupt lines, the solvent connecting carriers would initially dominate. (As we have seen, they are already laying their plans.) But a group of entrepreneurs could be expected to offer rail service soon. Freight forwarders and leasing companies would probably form the nucleus of this group. No significant capital investment would be required. Railroads already lease their motive power largely through equipment trusts. Privately owned freight cars are proliferating, partly owned by shippers, as in the past, who are not satisfied with the rolling stock offered by the railway company. Increasingly, private railway cars are becoming more attractive passive investments offering tax advantages analogous to those of real estate holdings. Whereas real estate investments typically require a fairly large equity, which often necessitates a limited partnership as a common form of organization, a railroad freight car requires only a four-figure equity, and hence is within the reach of the typical round-lot, common-stock, individual investor. Moreover, in 1975 a 10% investment tax credit is available for rail cars. That credit does not apply on real estate or common stock investments.

Much of the private business organization is already in place. Lease management companies place the investor-owned rail cars on long-term lease with grain companies, electric utilities, or oil companies, and contract for their maintenance.

The technology required to control variously owned trains is analogous to that used by the Federal Aviation Administration (FAA) to control aircraft, though considerably simpler, since it is linear rather than three dimensional. Control personnel could be employees of the organization that owned and maintained the right-of-way, of the Federal Railway Administration, or of independent contractors.

Control could be by two-way radio. Expensive line-side signaling is rarely necessary with the traffic densities of American railroads. Control of trains by radio would be much more positive than aircraft. Not only is train velocity only a small fraction of that of aircraft, the train driver can positively identify his location at any time, and he can stop. Radio control of trains seems much safer than that of aircraft. There is, however, a greater probability that a train will run along an occupied track than that two aircraft will attempt to occupy the same airspace.

Those using trackage rights would pay a toll, perhaps based on tonnage hauled, or a sliding scale based on gross weights per car, to provide for the additional wear produced by heavy equipment. The toll might include traffic control costs and fees for expedited service. Trackage rights are a common phenomena in present railway practice. Examples of long distances of common track include Southern Pacific and Burlington Northern between Klamath Falls and Chemult, and Southern Pacific and Western Pacific between Winnemucca and Wells. In some cases two railroads share a single track belonging to one of them. In other cases,

each company retains its own tracks with unidirectional operations over them. The present structure of intercompany payments for trackage rights constitutes still another model on which tolls could be based.

More entrepreneurs and innovative service will mean more trains, and hence increased requirements for railroad labor. Railway union membership has been withering from attrition. Twenty years seniority may be required for crew members to remain on the assignment board. The unions should be delighted with a proposal that may help rescue their declining industry. It is only second best to the safe government operation offered by ConRail. But ConRail projects only a 3% increase in employment over the next decade.[68]

Provisions for the supply of labor on board trains might be modeled after the waterfront hiring halls of the ILWU, or it might be provided by independent contractors, much as labor is supplied to some international or charter airlines. In either case, there would have to be certification of competence by an appropriate authority, just as the Federal Aviation Administration or the Department of Motor Vehicles now test the competence of those using public airspace or highways. A union hiring hall is most probable, since the competitive supply of transportation services will probably not engender a competitive supply of transportation labor. Note, however, that the other more competitive transport technologies do not have industrywide labor organizations, and do have a fringe of nonunion producers.

There are major terminals--Roseville, Colton, and Barstow--where trains are sorted out by long-haul destination, and minor terminals--Bakersfield, San Bernardino, Watsonville Junction, and Oakland--where cars are accumulated from shippers or distributed to consignees. The major and minor nodes may be less distinct in ConRail territory. But the yards already exist, often occupying too much valuable downtown land.

For the political organization of yards, one can consider the airports and seaport models. Terminals are assets to local economy. They attract labor to operate them and to man the long-distance movements to and from the terminals; they imply a break in the transportation process.

Such nodes in the transportation process, even freeway interchanges, attract industry. While the movement is stopped, there is the temptation to do something for it or to it, so generating local income. Terminals could be owned, for example, by local government agencies, or by turnpike landlords. Charges for the use of the terminal could be stated and billed separately to encourage through runs. Or terminals might be leased to wharves. Common rail facilities in St. Louis, Oakland, San Francisco, Stockton, and Washington are already well known, and some operational modeling has been done.[69]

Smaller terminals could be managed in the same way, with local entrepreneurs undertaking the switching movements to deliver and pick up cars

at local industries. Local industries might form cooperatives for that purpose, if no entrepreneur were available.

In many cases, rail service would become purely an industrial operation; since, for that purpose its technology is still so economical that new construction is undertaken. Bulk shippers or consignees of coal, iron ore, and grain might simply operate their own unit trains as part of their industrial processes, as might automobile manufacturers, who already use the rails as an extension of their assembly lines.

Conceivably, over-the-road common-carrier truckers might also employ unit trains or trailers on flat cars. That action would require a revision of their contract with the Teamsters, which now provides that if a driver is available he must be paid even if TOFC service is substituted. That revision might take the form of using rail-qualified Teamsters to man the truckers' unit trains, or it might follow the pattern of the settlement for the handling of containers on the Pacific waterfront. In the latter case, the employers made substantial contributions to the union's pension fund, which allowed the union to tie its members closer to it, and at the same time encourage a reduction in its active membership through early retirement.*

Rehabilitation of track presents the greatest problem. The USRA estimates that about $3 billion would be necessary to rehabilitate roadway and structures of ConRail over the next decade,[70] and the RSPO estimates that rehabilitation and modernization of track and equipment of all Class I railroads would cost upwards of $7 billion (RSPO, pp. 78 and 82). An even larger-scale program for which RSPO proposes a two-cent-per-gallon fuel tax would run to some $12 billion.[71] With Class I railways showing a deficit in 1975,[72] internally generated funds are clearly not available within the industry. Thus, the availability of federal modernization and maintenance funds might constitute an incentive even for solvent roads to abandon their 19th Century organization and to offer trackage rights to others.

The organization of highway funding may serve as a model for the development of the rails as public highways, i.e., by offering trackage rights to all. Main lines can be treated like the interstate system and be made eligible for primarily federal funding. Similarly, other lines could be treated like state highways, and light traffic could be largely consigned to local rsponsibility. Despite Fishwick's complaint that

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*Container service is, however, more economical than conventicnal, manual cargo handling by a very large factor of between ten and a hundred. Even if TOFC is more economical than over-the-road trucking, the advantage factor of its advantage is unlikely to be nearly as large, and of course, this factor quantified the motivation of management to compensate the union for changes in the agreed work rules.

the USRA Plan does not provide a private-sector solution to the rail problem, no completely private-sector solution seems possible; moreover, with the bankruptcy of the Rock Island and the emergence in 1975 of lower earnings for the entire railway system, the possibility of any private-sector solution seems more distant.

Imagination is seemingly in short supply. Although we are approaching the end of the 20th Century, none of the proposals so far moves far enough away from the forms of business and government organization created by the rail technology of the early 19th Century. By offering trackage rights to new entrepreneurs, innovative forms of business organization can be expected to emerge. Young people with new ideas can be expected to enter the industry. Private enterprise could be expected to thrive as it has within the highway system.*

Conclusion

Mechanisms for the use of the rail technology by the general public require much more exploration. The underlying concept seems to offer possibilities for the revitalization of a long-established form of transport. Current plans, on the other hand, risk developing an expensive venture into nostalgia. The authors plan to develop further detail for a model of the rail technology open to common use.

With all transport technologies open to public use, the need for elaborate economic regulations would wither. Deregulation would trigger technological and marketing innovations in ICT.[74] Presidential administrations including the present have consistently pushed in that direction.[75] Unfortunately, inertia is a great force, and the outlook for deregulation is not promising.[76]

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*USRA's FSP argues that it supports private enterprise,[73] but it can also be seen as a step toward permanent government control and the further institutionalization of 19th Century monopoly organization.

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XII. RESOURCE AVAILABILITY INPUTS TO INTERCITY TRANSPORTATION TO THE YEAR 2000: WITH SPECIAL REFERENCE TO ENERGY RESOURCES

by

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ABSTRACT

The 1975 to 1985 decade is a critical period in terms of U.S. vulnerability to economic interdictions of oil and OPEC-like raw material cartels and in terms of the formulation of a national policy on energy and resources.

A continuing rise in the cost of raw materials and energy resources will result from two factors: greater demand for scarce resources by more and more industrializing countries and the depletion of high-grade deposits of certain resources.

Government action or inaction will determine the nature and extent of the impact of resource scarcities. Government can puruse four courses of action: rationing and constraint mechanisms; minimal intervention; R&D and capital investments to produce substitute materials; and conservation and resource reutilization emphasis. A mixed set of strategies is, however, virtually inevitable.

At one extreme of a continuum of policy choices is a "heroic effort" scenario, involving a near-term, high-level allocation of both public and private capital investment funds to locating and exploiting available material and energy supplies. Serious infrastructure bottlenecks--oil refining capacity and the output level of equipment manufacture for offshore oil drilling , coal strip mining, and nuclear energy pressure vessels--mandate, however, additional major infrastructure investments and a reallocation of resources from other economic sectors.

At the other extreme of the policy continuum is a "stumble along and pray" course of action: low-level R&D investment; inattention to infrastructure bottlenecks; and uncontrolled price increases as a remedy for resource shortages, along with a government rationing mechanism using a nominal degree of equity in scarce resource allocations.

Regardless of the policy options pursued, a highly probable investment capital shortage coupled with rising costs of energy and materials development will mean stiffer competition among other activities, including intercity transportation, for portions of a shrinking investment capital pool. Generally, the capital shortage will militate against radically new ICT technologies which require entirely new infrastructures and will generate increased costs of both energy and materials used in ICT.

Both scenarios imply energy and resource scarcities at some point and a direct impact on ICT. In the "heroic effort" scenario, scarcities will develop in the relatively near-term because of an allocation of available capital resources to R&D and to renewable resources utilization strategies at the expense of funding discovery and development of renewable resource supplies (e.g., petroleum); at the very least, greatly increased costs would arise from near-term dependence on imported materials and

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energy resources. "Stumble along and pray" scenario problems include the insufficiency of this course of action to offset domestic energy producers' apparent disinvestment strategies or to attract necessary capital funding, and the continuing existence of infrastructure bottlenecks (especially with respect to technological innovations). In the absence of a varied policy geared to the entire energy and raw materials system (i.e., the entire economy), shortages will result, and long-range economic impacts will be enormous.

The "heroic effort" scenario could have additional ICT impacts. Fuel (especially petroleum) rationing is one possibility. Availability of abundant, relatively cheap, electric power from renewable sources could make railroad electrification far more attractive. Pressures for increased transport efficiency and optimized operations will probably lead to mode restructuring; a lean railroad system and water carriers would handle long-haul commodity movement, and highway goods transportation would be confined to relatively short distances as a feeder service for the most efficient long-haul carriers.

Within the "stumble along and pray" scenario, ICT would have fewer near-term impacts. Lack of capital funds would make for less upgrading and improvement of the existing plant, but service would continue for some time. Materials, especially fuel, shortages would have major impacts. The national economy might be restructured into regional, autonomous economies with minimal long-haul transport.

Substantial ICT costs will probably have several impacts: the demise of less essential transportation; a geographic restructuring of activities to minimize ICT costs; increased efficiency of ICT systems; and substantial changes in regulation.

Personal intercity transportation is in a somewhat different position than that of carrier modes. Business travel will continue unabated, regardless of fuel price, so long as fuel is available. Social and recreational travel depends, however, on both fuel price and availability. It is difficult to ascertain, however, the price threshold at which personal vehicle recreational travel is significantly affected; the "heroic effort" scenario would have near-term impacts, and the "stumble along and pray" scenario would have significant long-term impacts.

In short, the major impacts of resource and energy factors on ICT, due primarily to investment capital shortages, depend on the choice of policies pursued by the federal government. The system is currently oriented to utilization of nonrenewable resources with little investment in R&D or capital plant. At best, only relatively few state-of-the-art improvements can be expected up to the turn of the century.

XII. RESOURCE AVAILABILITY INPUTS TO INTERCITY TRANSPORTATION TO THE YEAR 2000: WITH SPECIAL REFERENCE TO ENERGY RESOURCES

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XII. RESOURCE AVAILABILITY INPUTS TO INTERCITY TRANSPORTATION TO THE YEAR 2000: WITH SPECIAL REFERENCE TO ENERGY RESOURCES

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Introduction

The discussion in this paper rests on two premises. The first of these is the usual *ceteris paribus* assumption that no major wars or disasters on a similar scale will befall. With the United States and other industrialized countries engaged in a race to provide sophisticated weaponry to some less developed countries and with the diffusion and consequently increased development of nuclear technology, the assumption appears increasingly tenuous. Nonetheless, it is an assumption that must be made.

The second premise is that intercity transportation is the central focus of this discussion. Particularly in a discussion of policy alternatives, that point of view should be differentiated from a national perspective. What is good for intercity transportation may not necessarily be good for the nation or a sufficient basis for a national policy. Nonetheless, the assumption is a necessary one.

1975 to 1985: The Critical Years

In looking ahead to the end of the century, the 1975 to 1985 decade seems especially critical. It is during this decade that the United States will be most vulnerable to the economic interdiction represented by the Arab oil embargo. It is during this decade that the formation of other OPEC-like cartels controlling the flow of scarce raw materials could be most harmful. In short, this decade is, for practical purposes, the make-or-break period during which national policy with respect to resources and energy will have to be formulated.

In addition, the coming decade is one during which a continuing rise in the cost of raw materials and energy resources must be expected. Cost increases will result almost inevitably from the operation of two factors. The first of these is market forces bidding up the price of scarce raw materials as more nations industrialize and as, generally, levels of living in many parts of the world improve. Also, and probably equally important as a price increasing mechanism, is the likelihood that the world will during this decade run out of high-grade deposits of a number of materials and will have to turn to less desirable sources with a consequent increase in the costs of processing and extracting needed materials.

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The U.S. economy will have to adjust to the new price structures and will probably require allocation mechanisms that differ rather sharply from those that have been dominant in the post-World-War II period. It may be appropriate to quote here a recent report of the National Academy of Sciences, *Mineral Resources and the Environment*: "An enormous amount of capital investment will be needed for energy supplies--through 1985, about 35 percent of all available investment capital, as compared with the current 22 percent--distorting the whole investment picture and denying needed capital to other industries, including the mineral industry."

The Role of Government Policy

Many other reasons could be brought forward to further underwrite the critical nature of the coming decade. However, most significantly, the character and direction of government policy will be the significant factor. It is government policy, whether action or inaction, that will determine the nature and extent of the impact of the changing resource situation, both as to scarcities and price increases, on the U.S. economy and on the level of living in the United States.

Prototypically, government can pursue four courses of action: rationing and constraint mechanisms; minimal intervention; high R&D and capital investments to produce substitute materials; and conservation and resource reutilization emphasis.

Clearly, government will not follow any one of the stated strategies in its pure form. A mixed set of strategies is virtually inevitable. In this context, it is worth noting that one cannot, in any realistic sense, speak of the existence of a market mechanism in the energy and resource field. Virtually all prices have, to a very substantial extent, become administered prices, whether the administering agency is national or foreign government, oligopolitically structured private industry or a multinational cartel.

Policy Scenarios

The question is, then, what mixes of policy might result vis-a-vis resources and energy? Since the number of possible combinations of policy is very large, it will probably suffice for the discussion at hand to consider the end positions in the continuum of policy choices.

At one extreme one may postulate a "heroic effort" scenario directed at fulfilling all of the objectives of Project Independence, and all of its thus far not-spelled-out implications, by the year 2000. Such a course of action would involve a near-term, high-level allocation of both public and private capital investment funds to the location and exploitation of available material and energy supplies.

This development emphasis is not as easy, by any means, as it is sometimes made out to be. There are serious infrastructure constraints; for example, there is only a very low level of current production of offshore oil drilling equipment; there is little production of the equipment required for efficient strip coal mining; there is little capacity for the manufacture of the kinds of pressure vessels used in the generation of nuclear energy; and oil refining capacity is severely constrained. Thus, even this often advocated course of action requires major investments in additional infrastructure and requires a reallocation of resources from other sectors of the economy.

Looking farther ahead, the "heroic effort" course of action would require major allocations of capital to research and development of new materials and new technologies as well as new energy sources, so that both new energy sources and the distribution systems required by these could come on-line at the end of the century. There is no question but that, in the interim, even with continued GNP growth and perhaps a resumption of productivity increases, the "heroic effort" course of action would cause a major reallocation of resources and would have, in the period during which it was pursued, significant effects on the production of consumer goods and services and thus on the quality of life.

While one cannot assume that all shortage problems can be resolved through an increase in investment in research and development nor that substitutes can be found for all exhausted, nonrenewable resources, one could, through a course of action involving heroic effort and some likely near-term shortages and economic dislocations, come to a situation in which energy would be available in abundance from basically renewable sources. Materials technology would then be much less dependent upon the use of nonrenewable resources.

The other end of the continuum might be characterized as a "stumble along and pray" course of action, characterized in the next ten years by a low level of investment in research and development, no effort to deal explicitly and consistently with the infrastructure constraints that affect energy and resource production, and efforts to meet shortages by permitting prices to increase. In this scenario, one must make the assumption that shortages that develop for one reason or another would be dealt with by a government-sponsored rationing system formulated to produce some degree of equity in allocation of scarce resources. The equity concept is, however, unlikely to be formulated in relation to concepts of the differential impact of the chosen allocation mechanism on various sectors of the economy.

In this latter scenario, one must expect very real problems of several kinds to develop. First, there is a very high probability that permitted increases in price would not be a sufficient mechanism to offset the apparent disinvestment strategies of some of the domestic energy producers or to attract the level of capital funding necessary. Similarly, it is unlikely that, without external incentives, a great effort will be made to overcome the previously mentioned infrastructure

bottlenecks. Also, the infrastructure to support technological innovation (e.g., a distribution system for methanol fuel additives, a support system for electric vehicles) is likely to be slow in developing.

The basic point is that in the absence of a very varied policy dealing with the entire system related to raw materials and energy, which for practical purposes is the entire economy, shortages will result, and long delays in being able to deal with them will ensue. These events will, however, be postponed to the end of the century. The long-range impact on the economy, and the society more generally, will be enormous and may even come to approximate the fearful predictions of the prophets of doom.

The actual course of action will no doubt lie somewhere between these two extremes. Exactly where will probably become more apparent in the next two to three years, these being critical with respect to policy formulation. At the moment, there is no doubt that the course of action on which the country is embarked lies closer to the "stumble along and pray" end of the continuum. The believers in the determinism of the electoral cycle will no doubt say that all this will change after this year's presidential election. Whether that will in fact be the case remains to be seen.

Impact on Intercity Transportation

The question then arises, how do the potential directions summarized above impact upon intercity transportation? Clearly, they do in many and complex ways.

At least one consequence of the materials and energy situation is likely to impact severely upon intercity transportation regardless of the policy options pursued: a highly probable shortage of investment capital. As indicated earlier, energy and materials development will, with the price increases already in effect as well as additional ones to be expected in the future, inevitably absorb a far greater share of available capital funds than has been the case in the past. Assuming that the recent trend toward a decline or stabilization of funds available for capital investment continues, all other activities requiring capital investment funding will have to compete for portions of a smaller pool. Given the not overly impressive past performance of the intercity transportation sector, the sector will have increasing difficulty in attracting capital.

The implications of a scarcity of capital funds are complex and are likely to impact intercity transportation modes differentially. Thus, it seems inappropriate in a very general paper to try to sketch these impacts in detail. Generally speaking, it is likely, however, that the scarcity of capital resources will militate against the introduction of technologies that are radical departures from existing ones and that require an entirely new infrastructure.

A second overall factor is likely to be increased costs of both materials and of energy used in intercity transportation. It is very difficult to find reasonable estimates of the rate and extent of likely cost increases over the next 25 years. The recent past has witnessed very large jumps in prices, particularly of fossil fuels, and some additional large jumps are likely in the very near future.

Several points occur in relation to these cost increases. First, the price of both materials and fuel drawn from the pool of nonrenewable resources is unlikely to stabilize until substitutes become available on a large scale. For example, if by the end of the century a very large proportion of the electrical energy in use is obtained from hydrogen fusion, if electricity is even more widely used than it is now as a substitute for fossil fuel in heating and industrial processes, and if electric vehicles are the preponderant means of urban transportation, then the need for fossil fuels may be relatively small compared to present requirements and ample quantities may be available for necessary uses. The point is, though, that price stability is in the rather distant future even under the best circumstances. Even though vast quantities of petroleum might be found along the continental shelves, the cost of petroleum is going to be higher than it was for the simple reason that the cost of production is going to be higher; and price, in any case, is going to be an administered one.

Further, regardless of price increases in materials and fuels, the costs of these are not likely to be the major determinants of overall costs of intercity transportation services. Labor costs, the cost of capital, and other cost elements have tended to rise very rapidly also and are likely to continue to rise. Such costs have historically been by far the greatest part of all of the cost elements in providing intercity transportation services.

Both of the extreme scenarios sketched above imply that resource and energy scarcities will develop at some point, early or late, and that these will impact in rather direct fashion on intercity transportation. In the "heroic effort" scenario with its long-range orientation and its emphasis on producing alternative materials and energy sources not principally dependent upon nonrenewable resources, the scarcities are likely to occur in the relatively near-term. Scarcities would basically be the result of an allocation of available capital resources to research, development, and implementation of a strategy centering on the use of renewable resources, thereby shifting capital resources away from discovery and development of supplies of nonrenewable resources, such as petroleum. If not scarcity, then the expectation, within the logic of this scenario, would be very much increased costs, because near-term dependence would fall almost entirely on imported materials and energy resources. In the longer term, that is, by the end of the century, the expectation within this scenario would be for relative abundance of needed materials and energy at stable if not lower prices.

In contrast, the "stumble along and pray" scenario implies, other things being equal, that in the near-term there would be no shortages of material and energy resources, although dependence on imports would be great and the costs of these resources would be high and would probably continue to increase. Scarcities are likely, however, to develop in the longer future as nonrenewable resources, both of petroleum and of certain metals, would begin to run out entirely without there being a usable and adequate set of substitutes for some period of time.

It is of course possible for the providers of intercity transportation services to pass most of the cost increases on to the user. Intercity personal transportation should be considered quite separately here. But, overall, the expectation must be that rising costs of intercity transportation, whatever the source of the costs might be, will force out less essential transportation. There is some evidence that this is already happening in social and recreational travel by the carrier modes.

If transportation costs, as a result of the various factors that have been considered, increase to become a larger component of the total cost of goods and services, some additional consequences may become visible. There may result in a geographic restructuring of activities to minimize transportation costs. The pressure to make the transportation system as efficient as possible would certainly increase, and substantial changes in regulation may result.

Additional impacts on intercity transportation can be inferred. An extreme version of the "heroic effort" scenario would probably involve the possibility of fuel rationing, particularly petroleum fuels, which would have a negative impact on the availability of air passenger transportation and, most likely, highway freight transportation. Generally, the near-term policy sets would probably favor the most fuel efficient modes of transportation.

In the longer term, this scenario is likely to result in even more fundamental changes. For example, only a minute part of the U.S. railroad system is currently electrified. Electrification has not been extended largely because it involves high costs and would not (and did not in the past) promise greater efficiency than the use of diesel locomotives. The availability of large quantites of relatively cheap electric power from renewable sources, including in the relatively distant future hydrogen fusion, could make electrification far more attractive. Pressure to increase transport efficiency and to use each mode in its optimal operating regime is also likely to lead to a restructuring of the modes. Long-haul commodity movement would be handled by a lean railroad system or by water carriers, and highway goods transportation would be principally confined to relatively short distances, providing feeder service for the more efficient long-haul carriers.

Similar restructuring might well take place on the passenger side. The essential point worth repeating, though, is that because investment capital will be so strongly committed to the areas discussed previously, the restructuring of intercity transport will likely take the direction of increased energy efficiency in relation to whatever principal types of energy might be available.

This scenario also indicates that, in the period beyond the turn of the century, if the basic energy and materials problems are reasonably resolved, there may be a great deal of innovation in intercity transportation. Presumably, other things being equal, once the more fundamental problems have been dealt with, investment capital would again be available for other sectors, including transportation. Research and development in intercity transportation in a manner far more focused and product oriented than the scatter gun approaches of the past ten or fifteen years may well begin in the 1990s.

Within the perspective of the "stumble along and pray" scenario, intercity transportation would, in the near term, be much less impacted. Lack of capital funds will make for even less upgrading and improvement of the existing plant, but service, much as it exists now, could be expected to continue for some time. The cost, as already indicated, will inevitably increase but, as also indicated, the cost increases can be passed on to the user.

Essentially, this scenario would indicate that the day of reckoning will be postponed, but that it would inevitably come, and come at a time when the intercity transportation industry would be ill-prepared to deal with it. Materials shortages would develop and would affect the industry, but fuel shortages especially would develop and begin to have major impacts, with the availability and evolution of substitutes and alternatives then postponed until at least the second decade of the 21st Century.

If energy shortages become so extreme that transport is seriously impaired, one can even visualize a restructuring of the national economy into a number of more or less separate, more or less self-sufficient, regional economies minimizing long-haul transport.

Personal Intercity Transportation

Personal intercity transportation needs to be treated somewhat separately from the carrier modes. The principal factors likely to affect personal intercity transportation are fuel availability and price.

Personal intercity trips using automobiles or similar vehicles are made principally for two reasons, business and social and recreational purposes. As long as the required fuel is available, it is unlikely that travel for business purposes would be very much affected, regardless of the price of fuel.

The situation with social and recreational travel would differ sharply, however, depending upon availability of fuel and upon price. This type of travel is essentially voluntary and subject to a variety of factors. If fuel is rationed or its availability is uncertain, there will inevitably be a marked decrease in social and recreational trips, particularly the longer types of trips which have become something of an institution in the summer time. Similarly, one must expect that substantial increases in the price of fuel will lead to a decline in social and recreational travel. A complex set of factors centered on available income for such purposes is likely to be a causal factor here. If inflation continues, and particularly if price rises of basic requirements such as housing, heat, electricity, and other necessities continue, without being offset by increases in personal income, a substantial portion of recreational travel by personal vehicle may well fall victim to the lesser amount of discretionary income that will be available for such purposes.

It is possible to visualize many situational factors that might affect or nullify this inference. The life styles of a significant proportion of the population involve the use, on an extensive basis, of recreational vehicles. These activities may be of such significance and centrality that other optional expenditures are foregone rather than limiting those involving travel. Behavior during and immediately after the recent oil embargo indicated a decline of such travel and a similar decline in recreational vehicle sales. However, both of these trends have been reversed since then. It is difficult to know what the price threshold is at which recreational travel by personal vehicle will begin to be significantly affected. It seems likely, in the near-term, that such travel would be more impacted under the condition of the "heroic effort" scenario than under the "stumble along and pray" one. In the longer term, however, there is no question that the shortages that would develop under the latter scenario would be so severe as to have a major impact upon social and recreational travel along with many other aspects of life.

Summary

To summarize, then, the inferences to be drawn from this rather cursory survey of the way in which resource and energy factors are likely to affect intercity transportation, it is reasonably apparent that the impact will be a major one. The principal source of this impact will be scarcity of investment capital, the scarcity being greater or lesser, more immediate or more distant, depending upon the policy sets pursued, principally, by the federal government. There are those looking at the same data set who would say that it is possible to have both "guns" and "butter," that the socioeconomic system can respond so that all difficulties and shortages can be obviated. The thought here is that a more realistic view is either guns *or* butter, and that a strategy of postponement, i.e., the choice of butter, will simply lead to a more severe and critical situation by the end of the century.

Given that the system is currently oriented to utilization, principally, of nonrenewable resources and that relatively small investments have been made in R&D and in developing a new and more useful capital plant, scarcities and limitations will make themselves felt one way or the other. Nonrenewable resources are by definition exhaustible or become so costly to use as to be noneconomic. Similarly, a low level of capital investment in an industrialized society, either to do research and development that will have future payoff or to bring the capital plant up-to-date, will make an impact later, if not sooner.

In a situation such as that, transportation does not fare well, because transportation can at best, as long as there is an adequately, if not efficiently, functioning system, claim no more than intermediate priority. Thus, the conclusion, that between now and the end of the century, only relatively small, though possibly highly useful, state-of-the-art improvements will be made in intercity transportation and that no great expectation of the implementation of radically new technologies should be entertained.

XIII. THE FUTURE OF CONCERN FOR THE ENVIRONMENT

by

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Peat, Marwick, Mitchell & Co.

ABSTRACT

This paper considers key issues, trends, and factors related to the future of concern for the environment.

A relatively low level of concern for the environment prevailed in the United States until the 1960s. The growth ethic approach to community and economic development was seldom questioned.

Minority-view groups and organizations can and often do hold the balance of power in American elections, which is increased even further when money and personnel are available. Many minority environmentally oriented groups have successfully applied this marginal control feature to get federal and state governments to enact needed environmental legislation.

The Sierra Club and similar organizations, the National Parks System, and the 1899 Rivers and Harbor Act, for example, developed the initial concern for the environment. Federally sponsored conservation-related job programs during the Depression also contributed. Environmental programs were also developed by companies attempting to correct damage they perpetrated and by agricultural business interest.

In the late 1940s, following a large influx of people into the cities during the war, water pollution problems intensified. In 1965, the federal government began enacting meaningful water pollution legislation. Air pollution also became acute during this period. Significant corrective legislation was finally passed in 1967.

Land must be considered a resource which, if improperly used, can have the same ill effects as pollution of air and water. Tax reform and increased state control represent the greatest chance for some modification of the land use problem.

Though initial environmental legislative efforts were relatively unsuccessful, they did establish research programs and funded educational grants, both of which later provided a considerable amount of scientific data to support the need for additional federal action.

The 1969 National Environmental Policy Act (NEPA) represented the culmination of public concern about unplanned environmental development. The Act directed all federal agencies to encourage a "productive and enjoyable harmony between man and his environment."

Though NEPA is seemingly devoid of enforcement and administrative provisions, the key to its success to date is the required Environmental Impact Statement (EIS).

A combination of factors and events--the Vietnam War, the fuel-oil crisis, Watergate, and an erratic economy--has resulted in a blunting

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of the overall environmental movement. A moderate level of concern for environmentally oriented problems is apparent.

Future debate of environmental quality will center around the identification of key environmental issues and standards by which the merit of an identified issue can be judged. Regional variations, geology, climate, etc., will, of course, be important. Considerations of environmental quality involve high cost. A universally acceptable level of environmental quality will consequently not be determined.

The NEPA's EIS will continue to affect most federal decisions. State, regional, and city governments will adopt some form of EIS process. Procedures should become more refined and straightforward, and the development of computerized models should permit a higher degree of sophistication.

Simple environmental solutions to the problem of waste management do not now exist. With the increasing scarcity of satisfactory and convenient urban fill areas, it is highly likely that the situation will reach crisis proportions in some areas.

While it is impossible to predict accurately future resource use and future resource supply conditions, as it is impossible to predict technological advances, an increased scarcity of resources could nonetheless generate a profound environmental impact. Interests who need resources will no doubt press for their extraction, regardless of consequences to the natural environment or to foreign political relations. Environmental interests will, of course, attempt to emphasize alternatives. Except for those projects which create numerous job opportunities, dollars for aesthetically oriented environmental improvements will be increasingly difficult to appropriate at any level of government.

XIII. THE FUTURE OF CONCERN FOR THE ENVIRONMENT

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XIII. THE FUTURE OF CONCERN FOR THE ENVIRONMENT

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The purpose of this paper is to set forth observations about key issues, prevailing trends, and other factors of relevance to the future of concern for the environment in the United States.

Part One of the paper discusses the context within which environmental concern is typically developed and/or expressed under a democratic form of government, and also traces the history of what is often referred to as the environmental movement. Part Two details a number of observations as to the form, degree, and extent of concern for the environment that may be anticipated over the next 25 years and beyond. A representative bibliography of reference sources is also included.

Part One: The Nature of Environmental Concern

It should be noted at the beginning that the emphasis of this paper is not on the future of man's environment *per se*, but on the future of man's *concern* for his environment. The underlying assumption is that the human environment is controlled by decisions of man; that such decisions are influenced by the degree of concern exhibited by man; and that the degree of concern is, in turn, influenced by the various components of society. The latter include political, religious, and economic components, in particular.

An understanding of the various observations set out in Part Two of the paper requires some agreement as to the terms "environment" and "concern." Unfortunately, a consensus as to what is encompassed by "the environment" does not exist at the present time, according to a recent survey sponsored by the Environmental Protection Agency (EPA).

The findings of this EPA inquiry revealed that conflicting definitions for the term "environment" were held by policy makers and managers at the municipal and county levels of government. Respondents were offered four distinct definitions. None of the four received a majority of votes. Each received one-third or less. The important conclusion drawn from this survey is that local officials do not have a uniform concept of the term environment; and that no simple definition exists.

Webster's New Collegiate Dictionary (Seventh Edition) defines the term "environment" as being our "surroundings." In a more technical perspective, this definition may be expanded to include our *natural*

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surroundings (air, water, land, flora, fauna, minerals, etc.) and our *human or man-made* surroundings (homes, factories, roads, and other structures).

Man has traditionally recognized himself as different from other animals, and throughout the known history of development has continued to enhance his personal surroundings at the expense of his natural surroundings. As a result, man has become ingrained with the philosophy that his existence is predicated not only on his control of the natural surroundings, but often on the full utilization of same. The concept of man over nature, the "I-it" philosophy, continues to be a dominant theme of man's activities. However, in more recent times, such as the past one hundred years or so, a new philosophy has been emerging, arguing that man is one with nature, the "we" philosophy.

Given the changing understanding of man's relation to nature, use of the word "surroundings" to describe the environment is perhaps inappropriate. Since this paper attempts to describe possible future changes in concern for the environment, the simple term "surroundings" will imply that such concern is equally distributed between man-made and natural surroundings. If the relationship between man and nature is in fact changing, then such a definition is inconsistent. What might be more appropriate is to define the term environment as the relationship between man and his surroundings. In this manner, we can then explore how man's interaction with nature might change over time.

The other term that requires some discussion is "concern." For purposes of this paper, "concern" will include any one of three actions: (1) perception of a situation, (2) awareness of alternatives, and (3) a commitment to pursue one or more alternatives. On any given issue, an individual can be at any one of the three stages of concern. In order to reach the second or third stage it is presumed that he or she passed through the preceding one or two stages, respectively. Only the last or third stage will produce any results. Further, since the alternatives can be either good or bad, the awareness acquired during the second stage can produce positive or negative results in the third stage.

As noted previously, our American society is made up of political, economic, and religious components, for the most part. With regard to environmental concerns, the political element is of greatest importance, because, of course, applicable laws and regulations are either made or changed via the political process.

The political system in the United States includes the various governmental agencies and bureaucrats together with those persons elected to represent the people. The "game of politics" is the effort needed to influence governmental decisions and actions. The reward and penalty situations in the political system, like the economic system, relates not to the total but to the margin.

For example, in an election the candidates of each party are virtually assured of x percent of the total vote simply because of party affiliation. Thus, what often determines the outcome of the election is not the 90% or so of the assured vote that each party will more or less evenly share but, rather, the uncommitted 10% in each case. As a result, this 10%-20%(±) acquires a power to influence the election outcome that is disproportionate to its size. Because of the predictability of the great majority of voters, minority-view groups and organizations can and often do hold the balance of power. Such power is increased even further when minority interests are able to provide money and personnel to assist in the financing of political campaigns. Throughout the past decade, in particular, many environmentally oriented groups have successfully applied this marginal control feature to get federal and state governments to enact needed environmental legislation.

There are differences of opinion as to just when "the environment" became a political subject. One school of thought points out that initial concern for the environment was expressed in the late 19th and early 20th Centuries with the formation of groups such as the Sierra Club, the Issac Walton League, and the Audubon Society, along with establishment of the National Park System and passage of landmark legislation, including the 1899 Rivers and Harbors Act. Other historians argue that federally sponsored conservation-related job programs of the 1930 to 1940 Depression era, as spawned by soil conservation, range management, and reforestation activities, among others, are representative of the real beginning of today's intense interest in the environment.

In retrospect, however, many of these earlier environmental programs were either self-serving efforts of the wealthy to preserve natural wonders from the ravishes of their own companies (at public expense), or they were reactions to crises which were threatening agricultural business interests at a time when life on the farm and the provision of jobs was most important to economic survival.

The more recent efforts at preserving the environment are apparently based on a wide-ranging grass roots concern for mankind's relation with nature. Such concern not only stems from study, observation, and experience with real environmental problems, but also from the opportunity afforded middle- to high-income interests to preserve what they perceive as the quality of life through the imposition and enforcement of environmental controls. Initiation of the latest approach began in the 1950s when independent researchers like Rachel Carson produced books such as *Silent Spring*, which told of the damage to nature produced by insecticides, herbacides, and other insect control chemicals.

During this same post-World War II incubation period, other problems were identified and many were experienced. Water pollution, a concern originally recognized in the late 1800s, had received relatively little

attention once the health hazards associated with the disposal of human waste had been addressed. But in the late 1940s, following the large influx of people into cities during the War, problems of industrial pollutants in water supply systems became a reality for many individuals and communities.

Initial legislative efforts provided some research money and a small program to solve such problems in the affected cities. However, by the 1960s, water quality problems had grown even more intense. For example, between 1961 and 1970 there were 128 known outbreaks of disease or poisoning attributable to polluted drinking water. Of these, 35 outbreaks (39,810 cases of illness) involved contaminated drinking water provided by or through public water supply systems. In response to the various crises, the federal government began to enact meaningful water pollution legislation in 1965.

Air pollution problems also became acute during this same period. In October 1948, an air pollution episode in Donora, Pennsylvania, killed 18 persons, and made nearly 6,000 persons ill out of a total population of 14,000. Similar incidents occurred in New York City in 1953, 1962, 1963, and 1966. It was estimated that 405 and 169 deaths, respectively, took place as a result of the last two attacks in the nation's largest metropolis. Again, early efforts by the federal government were insignificant in terms of fully or realistically dealing with the situation. Significant legislation was finally passed in 1967, but not until the public perceived that a crisis condition existed in certain areas.

Initial legislative efforts, as outlined above, may have been impotent in addressing the postwar air and water pollution problems. However, each of these early pollution control actions established research programs and funded educational grants, both of which later provided a considerable amount of scientific data to support the need for additional federal action.

The added scientific data did many other things too. For example, such data provided factual information to those who wrote "doomsday" essays, or, conversely, those who were skeptics of the doomsday approach. In any event, additional numbers of persons were educated to the fact that something had to be done to improve the deteriorating condition of our natural surroundings. Such data also pointed up areas in which research was lacking and thereby offered new horizons for budding scientists who filled numerous college classrooms during the mid-1960s.

In short, the early legislation, though ineffective at solving real problems, provided one mechanism for the educational exposure of many new people to pollution problems, and thereby contributed to the groundwork of what was to become a major environmental movement in the late 1960s and early 1970s.

Without a doubt, the most significant long-term environmental legislation passed at that time was and is the National Environmental Policy Act (NEPA) of 1969. For perhaps the first time, NEPA provided a means for changing the structure of decision-making on federally funded projects. The Act represented the culmination of public concern over unplanned development that was aided and abetted by federal grant money. As passed and subsequently amended, NEPA directs all federal agencies to comply with a national policy designed to encourage "productive and enjoyable harmony between man and his environment." The key to NEPA's success to date is the environmental impact statement (EIS) required by the legislation relative to every major federal action that has a significant environmental effect. While NEPA is seemingly devoid of enforcement and administrative provisions, its strength flows from the required public review process which provides the public with an opportunity to know of and support or challenge a given project.

Whether NEPA will continue to have its present strength and effect will depend in large part on the politics of environmental legislation. The loophole in NEPA is that Congress can decree the type of federal action that will or will not be considered of environmental consequence. The first and most recent example of this form of legislative action occurred during passage of the Federal Water Pollution Control Act Amendments of 1972. Specific provisions were made to apply NEPA to the construction of publicly owned treatment works, as well as to requests for discharge permits from new sources. However, exempted activities include such things as regional water quality management plans, new source discharge performance standards, guidelines for state control of nonpoint sources, and others. If such a precedent were to continue or be expanded during the enactment of future legislation, it is possible that the current effectiveness of NEPA could be greatly diminished.

Based on all of the foregoing, long-term trends in connection with the environmental movement can be summarized as follows:

1. A relatively *low* level of concern for the environment prevailed in the United States until the 1960s. Prior to that period, the "growth ethic" or "chamber of commerce approach" to community and economic development was seldom questioned and almost never challenged.

2. As air quality, water supply, traffic congestion and urban sprawl problems proliferated in our then fast-growing metropolitan areas, a widespread multifaceted environmental campaign gained momentum in the 1960s and reached a *high* peak in the last half of 1973. Passage of the National Environmental Policy Act in 1969 represents the signal achievement of this campaign.

3. A combination of factors and events--the Vietnam War controversy, the fuel-oil crisis of early 1974, Watergate revelations, and an erratic national economy--has resulted in a blunting of the overall movement, producing the present *moderate* level of concern for environmentally oriented problems.

Present-day environmental concern and perception of environmental problems seem to vary widely from one section of the country to another. Residents of states that are particularly coveted for their climate, beaches, mountains, lakes, and other natural attributes are more deeply involved in environmental issues than many of their less-favored counterparts. For example, Hawaii, California, Arizona, Colorado, Oregon, Washington, New Mexico, Florida, Virginia, Maryland, New Hampshire, Vermont, Wisconsin, and Minnesota are very conscious of environmental matters. This is in contrast to industrial states such as Ohio, Michigan, and Pennsylvania or plains states such as Texas, Oklahoma, Kansas, and the like. Alaska and several others seem to be somewhere in the middle, at the present time.

Part Two: Environmental Concern--The Next 25 Years

No one can chart the exact course to be taken by the environmental movement during the remainder of this century and beyond. However, a number of useful observations about the nature and direction of concern for the environment over the next 25 years can be drawn. Such observations--essentially indicators of likely change--are briefly described and discussed in the reminder of this paper.

The Environmental Quality Issue. A great deal of debate in the near future will probably focus on a more precise definition of "environmental quality." The debate will center around the identification of (a) key environmental issues, and (b) standards by which the quality or merit of an identified issue can and should be judged. Moreover, regional variations in geology, climate, and other natural factors will be responsible for the injection of differing personal values into this debate; and regional differences in governmental structure, as well as land and water ownership patterns, will mean dissimilar solutions will be applied to similar problems.

When dealing with issues relating to "quality," each individual and each unit of government must balance the general welfare, health, and safety aspects of a given environmental situation (and the costs of meeting those requirements) against solutions that involve a higher quality and perhaps more aesthetic treatment of that situation. Unfortunately, costs also tend to rise. As a consequence of this fact, and because of the aforementioned regional differences that do prevail

in the United States, it is anticipated that little or no real progress will be made in determining what constitutes a universally acceptable level of environmental quality.

Environmental Impact Statements (EIS). The environmental impact assessment process, as defined by NEPA and subsequent federal agency guidelines, will remain in effect, and its use will be expanded. The assessment process outlined by federal regulations will continue to affect most federal decisions. More importantly, perhaps, there will be a continuation of the trend toward adoption of some form of environmental impact assessment process by state, regional, and even city governments. This expansion of the impact review process will begin to deal with environmental issues that do not now fall under the federal review requirements. Depending on the extent of such expansion in the different regions of our country, many private development projects may come under the same scrutiny as public actions. The latter condition is already true in California.

As experience is gained by all interests who participate in the process, and as court decisions are handed down which clarify points of contention, procedures should become more refined and hopefully more straightforward. In addition, the continuing development of computerized models should permit a higher degree of sophistication in the field of environmental analysis, especially with regard to the fair and objective consideration of alternatives.

Regional Response Variations. As has been mentioned, some areas of the United States have been more deeply involved with the environmental movement than others. However, the low-interest group will need to pay more attention to environmental concerns in the future due primarily to the extensive institutionalization of the EIS process at all levels of government.

In contrast, states that now have a high level of environmental involvement may be expected to become increasingly embroiled in economic versus environmental trade-off controversies. Florida* is currently a case in point--a coalition of business and labor interests in this southeastern state is urging that legislation be passed which would mandate *economic* impact statements as a counter to federal EIS and the state DRI (Development of Regional Impact) procedures.

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*Florida is one of 20 states that have enacted environmental legislation in addition to NEPA. Additional states will no doubt join this list in the next few years

Intensity of Environmental Concern. The moderate level of environmental concern prevalent in the United States today should remain in effect throughout the last 25 years of the 20th Century *unless* a severe and prolonged economic depression takes place. If such a depression does occur, the need for jobs will tend to override the desire for better air quality and other environmentally oriented improvements.

In order to counter any depression-generated movements that could lead to a reduction in the current level of concern, environmentalists may be expected to argue that jobs and thereby economic gain can be created as a result of projects designed to effect environmental betterment. For example, a federally financed program to construct sewage treatment facilities that feature tertiary treatment could generate many jobs and, at the same time, improve water quality conditions wherever the facilities are installed.

As for the other side of the coin, an increase in intensity of concern for the environment is not anticipated *unless* a series of crises occurs over a short space of time (such as three major oil spills in various parts of the country within a three-month period). Even if such a situation were to arise, the authors of this paper do not believe that the higher level of environmental concern would last for very long.

Urban Development Patterns. A combination of rising costs, concern for the environment, congestion, overcrowding (perceived if not actual), and other factors have been collectively responsible for what is known as the no-growth ethic that has recently sprung up in many sections of the United States. In some instances, this ethic has also been nurtured by the "drawbridge" syndrome; that is, a conscious desire on the part of those who are "on the inside" to exclude anyone else from their community or neighborhood, if at all possible.

Regardless of the motivation for such antigrowth attitudes, this type of movement can and is having a profound effect on urban development patterns. One of these effects is to reduce the raw land usage rate heretofore typical of metropolitan areas (particularly in the post-World War II era). Another is to increase interest in the rehabilitation and improvement of deteriorating portions of our cities.

The end result seems to be growing support for an overall policy that maximizes the use of *existing* facilities and areas, and downplays the need for brand new provisions. Such a policy obviously has enormous implications relative to the planning and construction of major public facilities (airports, highways, hospitals, schools, etc.), as well as to the redevelopment of obsolete urban locales that may have been ignored or overlooked in the past.

Land Use Considerations. Until recently, land use considerations received far less attention in the United States than air and water pollution problems, in part because land use is a far more complicated subject than pollution. Nonetheless, the manner in which land is used constitutes a fundamental environmental issue, one that vitally affects transportation, housing, recreation, air and water quality, and even job opportunities.

One of the more serious conditions that needs to be faced before any significant change in our land use system can come about is the view that land is little more than a *commodity* to be exploited and traded. What is required, according to most urbanologists, is an ethic that considers land to be a *resource* which, if improperly used, can have the same ill effects as the pollution of air and water. However, in order to effect such an attitudinal change, the various levels of government will have to address the related problems of taxation, regulation, and the taking of private property rights.

Although the use/misuse of land will continue to receive a lot of rhetoric and written attention, effective ways and means to deal with this issue may not be possible until the end of this century, if then. Tax reform and increased state control over land use matters represent the greatest chance for some modification of this observation.

Development Costs. The twin influences of inflation and environmental concern have combined in recent years to make almost any type of development project a costly and time consuming proposition. This unfortunate trend is most likely to continue and may even grow worse over the next 25-year period.

Stated in another way, the environmental impact factor is now an integral part of what might be called the "development decision equation." If it remains there, as we believe it will, and if the rate of inflation continues (hopefully under better control than at present), then a significant amount of dollars and hours will be required to complete almost any major undertaking. The implications of this judgment vis-a-vis new or improved forms of intercity transportation would appear to be substantial.

Waste Management. The management of waste is expected to become an increasingly more important environmental issue in the next five to ten years. There is already a growing body of knowledge pertaining to management activities, environmental impacts, handling methods, and other factors relating to solid wastes which are typically generated in cities and other urban areas. Some practical applications of feasible technology, as well as continuing research programs in solid waste management have already been funded by federal and other governmental agencies, and such activities will likely continue.

Scientists researching new energy forms have also begun to consider the use of waste products. Their research has included evaluation of the direct conversion of waste products into energy, as well as the possibilities of recycling waste products in order to reduce energy consumption. Because such changes would involve the pricing mechanism of our economic and political systems, in that prices of some products are artificially high or low by law, modifications considered to be feasible are likely to be slow in coming. However, the proliferation of waste products, unlike air or water pollution, has yet to create a crises situation in the United States. Simple environmental solutions to this problem do not now exist and with the increasing scarcity of satisfactory and convenient urban land fill areas, it is highly likely that the situation *will* reach crises proportions in some areas. When and if that happens, the management of waste will become a serious environmental issue.

World Population Growth. If the world population continues to expand as generally anticipated at this time (over 6 billion people by the year 2000), the demand placed on the world's natural resources and food supplies will be tremendous. As the food supplies dwindle, the United States will be called upon to grow and export ever increasing quantities of food. If this condition comes about, it may well trigger extensive debate in the Congress and elsewhere as to the use of pesticides, fertilizers, and similar products that can and do generate environmental problems of one kind or another.

The food producing resources of the world are not capable of feeding a continuously expanding population. The "green revolution," which occurred between 1965 and 1969 has not been a permanent solution to the world's food problems. Instead, it has been a means for buying time to get population under control, to develop even more advanced technology in food production, and to change some attitudes about what constitutes a desirable way of life. Therefore, given the situation where millions of adults and children are starving to death in other parts of the globe, the need for more food may be expected to be debated not only on environmental grounds, but on the basis of moral responsibility.

Resource Depletion/Technology. While it might be desirable to bring the production efforts of all nations to levels currently enjoyed by the United States and a handful of other highly industrialized nations, the resources of the globe--given current levels of technology--will not permit this to take place. The enormous growth of developed nations has not been made possible via the advancement of technology alone. A supply of natural resources was also needed and this demand was often met through importation of raw materials from less developed nations. Today, as these underdeveloped nations grow

and require more of their own resources for their own industrial needs, their interest in exporting raw materials to already developed nations is not likely to be enthusiastic or cooperative.

While it is impossible to accurately predict future resource use and future resource supply conditions, just as it is impossible to predict future technological advances, an increased scarcity of resources could nonetheless generate a profound environmental impact. Interests who need such resources will no doubt press for their extraction, regardless of consequences to the natural environment or to foreign political relations. In the United States, environmental interests will attempt to emphasize alternatives, some of which may not be economically or technologically feasible at the time. The Colorado oil shale debate now in progress is most representative of this contention.

Aesthetic Considerations. As costs continue to rise, and community priorities become more and more difficult to resolve, it is anticipated that public dollars for aesthetically-oriented environmental improvements will be difficult to appropriate at any level of government in the near future. Examples of such improvements include open space, national seashores, wilderness areas, and view protection or enhancement projects. Efforts of this nature that clearly involve numerous job opportunities could be exceptions to this judgment.

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ABSTRACT

This paper characterizes the social and attitudinal context within which transportation development, investment decisions, and regulation are expected to occur. No attempt is made to draw direct implications for intercity transportation.

Every U.S. post-war period has had problems of social stagnation, inflation, recession, and general pessimism. In the post-Vietnam years, a mood of alienation and pessimism is widespread and growing, because of the stalemate of Vietnam, the collapse of the Nixon Administration, distrust of government and business, the loss of discretionary income by American workers through inflation and recession, and a high unemployment rate. Millions do not vote or otherwise participate in the political process.

Business managers show their loss of confidence by going out of business, not adjusting to regulatory changes, and hiking prices substantially to generate excessive profits as a hedge against the future.

While the Black social movement has had ramifications for federal spending and education, the women's movement has brought about additional and profound social changes: laws prohibiting sex discrimination; changing roles of husbands and wives in child-rearing and working; and the rising number of career women in business.

Coupled with an increasing population is the shift of population away from larger cities toward mid-size ones. The national birthrate is declining, and family sizes are reducing. A very large increase in the number of single-parent and separated families has occurred. With changing sexual mores have come increasing sexual activity, contraception, and abortion.

The growth of gross national product (GNP) and personal income was significant through 1973, effecting a growth in the size of the middle class population. A boom arising from this affluence occurred in recreational and other luxury industries, and in the number of people enrolled in higher education institutions. Rising "quality of life" expectations have, however, contributed to declining levels of satisfaction.

Two critical facets of the U.S. employment picture are automation and a labor shortage in the midst of an unemployment crisis. Automation has eliminated unskilled and semiskilled jobs, and has increased the number of boring materials-handling jobs and the demand for certain high-level, specialized positions (e.g., in electronics and data processing).

The recent introduction of employment and admission quotas based on sex, race, or national origin by the federal government has severely damaged the traditional value of individual performance, and it may, in the long run, retard the process of racial and economic integration.

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The computer has had the greatest impact of all modern innovations on individuality. The living human core of business organizations is lost. One's identity is replaced with a coded number. The computer is the perfect "fall guy"; all errors and difficulties are passed off as the fault of the machine.

Industrial and office workers have pushed for improved working conditions and fringe benefits and for a voice in policy-making and personnel practices. Minorities, because of disparities between their incomes and those of whites, will press more vigorously for relief.

Two diverging "societies" have emerged: an urban-pluralistic society, and a mid-American and southern society. One result of this drift has been the refusal of suburban and rural areas to alleviate the financial and social plight of urban areas; while the urban dweller worries about mass transit, the mid-American seeks commercial aviation for his town and more, better roads for his car.

The overwhelming fact of life in the three major U.S. industrial corridors (Boston-Washington, Evanston-Chicago-Gary, San Francisco-San Diego) is stress due to irritants, affronts, and sensory shocks: air, water, visual, and noise pollution; accidents; crime; and inner-city poverty.

The high level of expectations of Americans for both domestic and foreign travel were met by an aggressive and growing airline industry. The desire to travel has become transformed into a perception of a right to travel; groups such as the elderly and the physically handicapped have pressed for low-cost fares and mechanical equipment to allow them the same freedom of access to travel as the general public; to accommodate these demands would mean a substantial cost overburden imposed on all other travelers.

One particular traveler concern is the transportation interface, the major source of transport system inefficiency: inconvenient or nonexistent parking facilities around airports and train stations; slow or intermittent service on ground carriers from airports to downtown areas; and substandard, low-security terminals for rail and bus transport systems.

The momentous task of rebuilding public confidence awaits federal and state governments. The federal government has already perceived that the electorate will give it a mandate to correct business abuses.

Transportation systems will have to be planned to provide an increasing degree of local self-determination. The success of any long-term transportation system investment is directly related to its acceptance and use by the public. Gaining acceptance, however, is difficult in a divided and emotionally charged political arena.

XIV. SOCIAL IMPACTS ON INTERCITY TRANSPORTATION

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XIV. SOCIAL IMPACTS ON INTERCITY TRANSPORTATION

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Introduction

The present paper examines and seeks to illuminate a number of qualitative social and psychological issues which may affect intercity transportation systems. An adequate understanding of any complex of human activities requires an examination of the less determinant social and psychological forces, as well as a comprehension of the hard economic facts. Often the inspirations of the artist and musician foreshadow the insights and analyses of the scientist.

While popular fads and enthusiasms are short-lived, major social movements can only be minimally altered in two generations. There is every reason to believe, therefore, that most present day social forces will still be in evidence in 2025. Once a popular mood becomes institutionalized in law, as with the passage of amendments to the U.S. Constitution, effects may be felt many decades after the debate of the moment has passed.

We do not doubt that the American governmental and economic system, although presently going through a period of adjustment, is still a viable and maintainable method for offering personal economic advancement and private freedom to the greatest number of citizens. The authors' long-term expectations are for the American people to continue their leadership in the solution of both human and technical problems. This leadership will pass through periods of turmoil and serenity, but it will continue. The long-term economic future of the United States is strong, and there is no evidence to suggest that there will be any fundamental alteration in the increasing economic output which has characterized the growth of the United States for these last two centuries.

While the general mood of the present paper is decidedly "down," we have deemed it appropriate to call attention to a number of negative factors that we believe deserve consideration. This mood, however, does not in any sense reflect a doomsday outlook; quite the contrary.

The major concern of the present paper is to characterize the social and attitudinal context within which transportation development, investment decisions, and regulation are expected to occur. The paper is seen as providing important background to other papers in this series, particularly those on implementation, regulation, and finance. It has not appeared appropriate, therefore, to attempt to draw direct implications for intercity transportation. The melange of changing and emerging values, attitudes, and feelings in American society, often sharply conflicting, represent the well from which politicians derive their constituencies, and which collectively define the mood of the nation.

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Social and Psychological Undercurrents

The Europeans of the last century were accustomed to speaking of the *Zeitgeist*, or "timely-mood" of a culture or people. After every war in which the United States has been engaged there has followed a period of social stagnation, inflation, recession, and general pessimism. One outstanding exception was the period following the Second World War. In some ways, it may be said that for America the Second World War dragged on from December 7, 1941 until the final American pullout from Vietnam, some 34 years later. No single influence has so impacted and structured the present state of American public opinion and mood as that 34 years of tension and foreign military conflicts, notwithstanding the interludes of "peace."

While the immediate decade after the Second World War, 1946 to 1956, was one of unparalleled growth and success, vast military expenditures went unabated throughout the period. The 16 million men and women who served in the armed forces in the Second World War participated in one of the most total victories in the annals of warfare. They were convinced that the rightness of American technology and political viewpoint were unassailable, as proven by the military triumph. They picked up their careers and family experiences in a world in which the mainland United States was one of the unscathed nations and in which American industry and economics were dominant. The same methods of management and production which had brought the War to an end were applied to the era of peace.

The first decade after the War brought vast prosperity, including a baby and housing boom and the innovation of universally appealing consumer products, such as television and high-fidelity sound. In the U.S., it was assumed that the American concept of the world, which had been tested in wartime, was both right and proven. Along with the sheer possession of many new consumer objects, new habits of living were spread to more and more citizens. Millions of post-War American families became accustomed to private luxury cars, paid vacations, and suburban living as simple matters of course.

This bright picture began to darken slightly with the opening of the Korean War in 1950. The debate within the United States began to center on the policy of containment of communist expansion. From that time on, one military commitment seemed to follow another with no apparent outcome. The post-War generation in all countries began to grow to adulthood. In Western Europe and the United States, they grew up in unparalleled affluence. The defeated axis powers, Germany and Japan, participated in this affluent outburst to a greater degree than most of the victors.

Along with this affluence came an increase in educational opportunities and a sense of expression. This indulgence was shattered by one singular difficulty, and that was the continuing drain of the young manhood of the U.S. into foreign military commitments. While their parents

grew up in a period of peace and were called to war as adults, the children of the post-War baby boom grew up in a country continually at war, a decisive factor that has been a major cause of a vast generation gap which has now existed for nearly two generations.

While the World War II generation never seriously accepted any other world view than that of the Republican-Democratic establishment in Washington, D.C., the post-World War II generation has continually refused to accept this world view without serious qualification. This deep-seated difference in viewpoint has been the direct cause of many other rejections of customs and mores by the generation of the 1940s and the 1950s. The following sections examine some of the most widely felt social and psychological undercurrents abroad in contemporary America.

Ambivalent Attitudes of Optimism and Alienation. Even though the U.S. extricated itself from Vietnam, shifted the presidency from the Nixon to the Ford administration, and maintained a reasonable distribution of oil and gas in the face of the energy crisis, a deep mood of alienation is widespread and growing. While optimism about the American economy has kept the stock market from a serious decline and brought down the prime interest rates, there has appeared a mood of pessimism among all levels of society, which has been increased by the high unemployment rate.

Deeper and more pervasive than considerations of the day-to-day stock market quotations, a deep-seated resentment has been growing since the 1960s.* This feeling is found in all levels of society, all ages and conditions, and all economic situations. Three factors have contributed to its reinforcement and extension: first, the stalemate in Vietnam and the realization that the same paralysis of policy which typified the Korean War is still in effect at the highest levels; second, the compromise and collapse of the Nixon Administration; third, the loss of discretionary income on the part of the vast mass of American workers through inflation and recession.

The presence of this resentment or alienation makes its appearance in increased incidence of social or personal dysfunctional behavior and a wide variety of outward antisocial acts.** To mention only a few of the indicators:

- Increased divorce rates, wife and child beatings.
- Increased drug addiction and alcoholism***

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*"55% Mistrust Government," *Philadelphia Inquirer*, Tuesday, June 10, 1975; D. Hapgood, *The Screwing of the Average Man* (N.Y.: Doubleday, 1975).

**K. Keniston, *The Uncommitted: Alienated Youth in American Society* (N.Y.: Harcourt, Brace & World, 1965).

***T.B. Szasz, "The Ethics of Addiction," *Harper's Magazine*, April 1972.

- Increased street violence and aggravated assaults
- Increased white-collar crime and industrial sabotage
- Increased arson and insurance frauds

Somewhat the same alienation has also been evidenced by businesses. Since, after all, the managers of businesses are also citizens, they are subject to the same moods and psychological pressures as the rest of the population. Being producers, they cannot display their concern over an insecure economic future in the same fashion as consumers. Their fears have been passed on in a variety of ways. The simplest is to not adjust to changing regulatory demands, labor negotiation, or whatever and to lock up and go out of business. Another, is to "go public" and then sell out. In those industries such as food preparation and supply where there is inelastic demand, this loss of confidence can be evidenced by substantial and unparalleled price hikes. Certain producers will seek to hedge themselves against the future by attempting to generate excessive profits.

The consumer has been faced with "sugar crises," "beef crises," "toilet paper crises," "soap and detergent crises," and similar excessive, temporary upheavals in the price and availability of basic commodities. These upheavals are ultimately as much caused by panic buying and synthetic shortages as any other factors.

The heart of the matter is the restructuring of public confidence. In a complex society such as America in the third quarter of the 20th Century, there will always be a percentage of the population who are dissatisfied with their situation and who have neither the ability nor the intent to improve it. However, this should not be a very large or well-distributed minority. At the present time, there are millions of Americans who feel that they are not, and perhaps will not, be able to keep themselves out of poverty. Many feel betrayed by the very institutions founded to protect and further their interests. Public opinion polls of the elderly, the factory worker, the school teacher, the unionized production worker, the college student, the financial analyst, the physician, and other social groupings, show that the majority are troubled about the social and economic future of the country and are suspicious of government and business at all levels.*

The most openly visible alienation is among the racial-ethnic minorities. In the Black and Spanish-speaking communities there are children growing up in the third, fourth, and even fifth generation in families on relief or other social assistance. There are pockets of minority persons where

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*O. Demavis, *Dirty Business: The Corporate Political Money-Power Game* (N.Y.: Harper's Magazine Press, 1975).

not one member has held other than a part-time or temporary job since the Second World War.

This class was the rare exception only five years ago, but now they are being joined by thousands of youths and Vietnam veterans who have tired of looking for work or a productive position and have dropped out of the bottom of the American class structure. These people are not even tallied in the unemployment figures and in most cases are past their allotments for any type of public assistance. Just how many Americans are in this number has been variously estimated at from 750,000 to 15 million, which indicates the lack of data and interest in the problem. They are a highly mobile group and will often move with the seasons around the country. With respect to various manifestations of alienation, it is important to recognize that there often exists structural alienation coupled with feelings of alienation.

Changes of Traditional Roles Within Society. Two major social rearrangements have come about since 1950. The first is the new importance of civil rights. Beginning in 1954, the impetus for civil rights legislation and the whole process of attempting to provide equal advantage (often entailing special advantage) to members of minorities for better distribution of social and economic benefits has become part of the American legal system. The new social motivation and mobility of Blacks has been followed by organized women's groups.

While the Black social movement has had ramifications for federal spending and education, additional and profound changes in society are now coming about with changes in law brought about by the women's movement. Already the alteration in management in many public institutions away from men and in favor of women has had a marked influence.*

The United States 1970 Census showed 104.3 million women over the age of one year and 98.9 million men over one year. The female life expectancy in 1972 was 74.5 years as compared to the male life expectancy of 66.6 years. Several detailed studies of the historical role of women in English-speaking societies have concluded that five interrelated innovations have brought about the current situation of civil rights activism. These are: the industrial revolution, which brought women off the farms to work in factories; the perfecting of the typewriter and telephone, which created the role of secretary-typist; the development of total war, which forced the use of women in the manufacture of war materials; the advance of the electronic media, which gave alternative opinions a voice; and the development of the birth control pill.**

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*M. Eastwood, "The Double Standard of Justice: Women's Rights Under the Constitution," *Valparaiso University Law Review*, 5 Vol., U.L.

**W. White, Jr. (ed.) *The New Woman* (Philadelphia: North American Pub. Co., 1972), pp. 9-14.

To date, the American industrial and commercial complex has been the most reluctant of institutions to accede to the pressure of feminism; although such capitulation is bound to occur. The long-term effects of feminism as a social undercurrent are undeniable as they are being felt already at every level of American public and private education. Recent Supreme Court decisions and agency guidelines have demanded compliance with a nonexclusion principle based upon sexual difference. This means that many of the assumed roles of male and female in American society are intentionally being programmed out of public education, whether for good or ill result cannot yet be determined.

The role of the woman will command consideration of another viewpoint as has the alteration of the role of the Black within the corporation. Feminist and minority viewpoints will be heard and are already dominating some fields of endeavor. As new legal structures institutionalize these role changes, there will be basic and far-reaching implications for all of society. For example, rather than having a husband work 40 to 48 hours per week while the wife cares for one or more children, it may become feasible for the wife and husband to each work possibly 25 hours per week, and each in turn may be responsible for child rearing. Such systems are already being adopted on a small scale in Sweden, Denmark, Finland, Holland, and other countries.

At a broader level, this newly changing role of women will ultimately mean a decided restructuring of American labor, one in which women will insist on maternity and child-rearing leaves and long-term employment commitments. The present situation of rapid turnover of female employees is already beginning to change.

The major force of the role-change undercurrent is in the roles that women see for themselves.* A young woman employee entering a major institution such as a bank, hospital, or manufacturing organization no longer sees herself as merely fulfilling a role as a restricted functionary within the firm. She sees herself as a potential candidate for a higher managerial position and as a direct competitor to all of the other management trainees, male and female. This change from a "mere job" to "career" orientation will cause vast changes in the internal organization of business. While social and economic class and regional considerations also come into play, the general thrust of feminism is clearly already at work.

Attitudes Concerning the Size and Pervasiveness of Institutions. With the coming of electronic data processing and information automation, economies of scale could be realized in human transactions and communications, as well as in the massive manipulation of facts and figures.

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*C. Mattiasson, (ed.) *Many Sisters: Women in Cross-Cultural Perspective* (Glencoe, Ill.: Free Press, 1974).

The size and impersonality of most institutions grew by a factor of two and more with the new information processing tools. At the same time, approximately the early 1960s, a deepening mistrust and resentment of government and industry began to appear. While attitudes involving mistrust of big government are endemic and almost prototypically American, the key is whether they are coupled with hope or despair. The early history of the country was certainly characterized by an almost boundless hope and confidence that rational solutions would emerge or be found for all problems. More recently, however, there is evidence of increasing despair and loss of confidence.

The many consumer and public advocacy groups which have recently arisen have served to further catalyze and focus anti-institutional sentiment. One manifestation has been a dropping off of membership in almost every kind of large-scale organization. For example: in the two years 1973-74 and 1974-75 loss of membership has been reported for organizations as diverse as:

- Boy Scouts of America
- AFL-CIO
- American Heart Association
- American Legion
- American Medical Association
- National Association for the Advancement of Colored People
- Klu Klux Klan
- Socialist Labor Party

Interestingly, consumer and environmental interest organizations have also had trouble maintaining membership. In part, such organizational decline is also related to a retreat to privatism.

In addition, the incidence of computer frauds and minor sabotage has risen steadily until record security is an acute problem.* Unfortunate as petty destruction may be, the real problem is the large number of individuals who just turn their back upon the institutions. There are millions who no longer vote, register, or take any part in the political process. There are additional millions who distrust all and every type of large corporation, school, hospital, state or federal office or agency, and all similar institutions.

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*S. W. Liebholz and L. D. Wilson, *User's Guide to Computer Crime* (Radnor, Pa.: Chilton, 1974).

As in the case of the current general pessimism in American society, the revelations of the Watergate era will have lingering effects on confidence in government, with doubt and pessimism giving way to cynicism. The payoffs granted by large American businesses, the feather-light sentences given major political conspirators, and the continuous illegal spying on American citizens have eroded faith in the structure of the government to deal effectively and impartially with abuses either inside or outside of government.

At the consumer level, the continuous revelations of faulty and dangerous foodstuffs, automobiles, and electrical appliances by "consumer advocates" has left the majority of Americans very wary of the goods they purchase and aggressive in pursuit of what they perceive as any attempt at "welshing" on the part of big business. Almost characteristically, "consumerism" itself has become big business.

A further important indicator of this distrust of the large institutions in American society is the unwillingness of many of the best young minds to go to work for them. The trend, which is now ten years old, is for many young physicians, lawyers, engineers, and others to work for public interest and other service organizations rather than for the giants of American industry and commerce.* It is not clear just how deep and abiding this antagonism will be. Part and parcel of this distrust of large institutions is the inability of individuals to relate on a human scale with such institutions.

These attitudes can appear in any number of variations and combinations. The important aspect is that they are found at the center of consciousness of a vast majority of Americans. The causes and directions of these attitudes are much too interrelated and complex for complete analysis. Bundles of such sensibilities lie just beneath the political and economic events of our times.

Major Issues in the Social Sphere Affecting Transportation

Increases and Shifts in Population. Most of the problems and difficulties in the supplying of food and basic commodities, energy included, go back to the problem of expanding population and the inability of the world economic, social, and legal system to cope with it. In the United States, the population has continued to increase at every decennial since 1790. The only two periods when it showed significant lags in increase were the periods of the Civil War and the Second World War. The most conservative estimates put the present population of America at about 207 million. The expectation for the population over

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*W. H. Sewell and R. M. Hauser, *Education, Occupation and Earnings* (N.Y.: Harcourt, Brace, Javanovich, 1975).

the next 50 years is for 267 million by 2025. This will mean an increase from the present 60 persons per square mile to nearly 75.*

The shift from rural to urban was most pronounced from 1939 through 1959. However, a more recent tendency is for the larger cities to lose population while the mid-size cities gain it. There is no question that this trend will continue. Clouding the population picture are the two recent social phenomena discussed below.

Decline in the Birthrate and Reduction in Family Size. In the last five years, there has been a definite decline in the number of births in the United States, as much as a 55% drop over the baby boom days of the late 1940s. The specific figures in live births per 1,000 population are as follows: 1970, 18.4; 1971, 17.3; 1972, 15.6; 1973, 14.2; (and projected for 1974 and 1975) 1974, 9.8; 1975, 8.3.** This has not decreased the overall population because of the relatively young median age of the U.S. population which is now about 27 years. Of greater importance is the very large increase in single-parent or separated families. In some areas of the U.S., notably California, the divorce rate is now about equal to the marriage rate. The fertility of continued marriages, i.e., number of children produced, is equal to families ultimately split by divorce with the result that large numbers of single-parent households have come into existence.

Sometime during early 1975, the changing birthrate is expected to again produce 1.87 children per American family which was set in the depression years 1929 to 1939. This will mean that in the foreseeable future there will be fewer and fewer members in any given family group. The number of subnuclear families of a child (under 18 years of age) living with one adult, whether mother, father, or some other relative, is increasing rapidly.

Alteration in Sexual Mores. The contraceptive pill was invented in 1961 by the pharmaceutical firm of G. D. Searle. Several other changes in the social mores concerning sexuality appeared at the same time. One was the increased use and distribution of other contraceptive devices and the more active sex roles of women. Despite the enthusiasm for the "new morality" or situational ethics, there has been no appreciable increase in sexual promiscuity in the U.S. However, there has been a large-scale increase in nonmarital cohabitation. Such arrangements between consenting adults have made their impact upon the overall birthrate, even though this is assumed to be relatively small. The broadening sexual morality has also meant that many young women are more

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*U.S. Bureau of the Census, *Current Population Reports*, series P-60.
**U.S. Bureau of the Census, *Current Population Reports*, series P-25, No. 521.

likely to travel and live apart from the previously considered "male guardian," whether father or husband. This has definite ramifications for the whole notion of security.*

There is no evidence to suggest a reversal of the trends in sexuality and sexual expressiveness. However, as with the Japanese experience with massive programs of birth control and government-supported contraception, we have seen a sharp drop in the birthrate at the same time that there is a rise in sexual activity (among the aging and the young unmarried) in the general population. In Japan, this has led to a very definite labor shortage; whether it will do so in the U.S. remains to be determined.

Another aspect of the alteration in sexual mores is the widespread and very popular introduction of legalized abortion. Although there will be some long-term opposition from the Roman Catholic, and certain Presbyterian-type churches, and various "Right-to-Life" groups, there does not appear to be a strong concerted movement to severely limit the statutes as approved by the U.S. Supreme Court. It is now estimated that as many as one of four pregnancies in the U.S. are terminated by therapeutic abortion in a gynecological clinic or acute-care health institution. This will be a definite depressant to the birthrate and the size of the population a decade hence and probably more so each decade thereafter. The national goal of zero population growth based upon "replacement reproduction" was posited on the assumption of a static state of immigration. Since there has not been a consistent policy concerning immigration, a readjustment of the projected population for 2025 is probably needed.**

Rise in "Quality of Life" Expectations. It has often been asked: What social force impelled the civil rights and other upheavals of the 1960s? The answer is the growing expectation of better economic and social conditions which grew out of the boom in business production and sales after the Second World War. The expansion came almost coincidentally with the wide-scale marketing of television to the American consumer. The two forces combined to show, through that medium, desirable new products which greatly increased consumer appetites and expectations. Of course, the impact of TV has been much more pervasive, touching as it has, heightened awareness in political, social, educational arenas.

Economic Growth. The United States came out of the Second World War with its vast economic and industrial machinery intact and

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*B. I. Nurstein, *Love, Sex and Marriage* (N.Y.: Springer, 1974).
**_The United Nations and Population: Major Resolutions and Instruments_ (N.Y.: U.N. Fund for Population Activities, 1974).

producing at full potential. The U.S. held the commanding economic lead in the world and in 1948 envisioned no peers. The GNP (in current dollars) was $284,769 million in 1950, rose to $977,080 million in 1970 and to $1,294,919 million in 1973. While the GNP rose so substantially, the personal income of Americans rose at essentially the same rate. The figure (in current dollars) stood at $277,619 million in 1950, rising to $800,290 million in 1970, and to $1,035,400 million in 1973. This gave the average American family the highest standard of living in the world for all but the last few years, with the special exception of certain small, restricted European states, for the first time span from 1939 to 1973 or 1974.

Increase in Wages and Salaries. The growth in GNP and personal income is even more vivid in terms of per capita income during the same period. It rose from $1,501 in 1950 to over $4,921 in 1973 (in current dollars). When it is recognized that this tripling occurred within the working career of many millions of Americans, who are still very much a part of the labor force, the psychological effect can be realized. Such sharp increases in wages and salaries meant that many workers who began in the lower and lower-middle class in the 1950s, rose to the middle and upper-middle class by the 1970s. An even more interesting indicator is the boom in recreational hardware, recreational facilities, the "experience business," and similar luxury industries. A number of studies have revealed that the overwhelming majority even below the poverty line in America, live among a plethora of automobiles, telephones, color television, and convenience foods. Given this, one might well ask: how ought such people react to galloping inflation?

Increased Education. With the increase in personal income came the chance for acquiring other habits previously the domain of the upper class on the economic ladder. One of the most prominent of these acquisitions was higher education. In a typical suburban high school in one of the areas surrounding an American city, 20% of the students went on to higher education in the decade of the 1950s. In the 1960s this rose to 55% in an average year, and by 1972 it was over 60%. On the national scene, the student population in post-secondary schools of all types was 2.2 million in 1950, which rose to 8.2 million by 1973. The percentage rise from 1950 to 1960 was 61.2% and from 1960 to 1973, 111.7%. Before the recent downturn due to the slowdown in the job market, the student population was projected to climb to 11 million by the year 2000.

This increase in education not only meant a strong rise in the qualification of job seekers, but also some unique corollaries in the patterns of American higher education. Four of these shifts are of importance.

- A shift of student enrollments away from the exact and technological sciences toward the social sciences, humanities, and arts.

- A high degree of skepticism concerning what had been presumed to be the "verities of science."*

- Increasingly more sophisticated types of pressure being brought to bear, first, upon the academic institutions, and second, upon the legislative branches of government.

- A large increase in the size of the professoriate, with an attendant increase in public visibility and political power.

The overall effect of this increase and shift in educational experience has been a loss of mandate by almost every level of government and a marked increase in the popularity of political "independence" from the major parties. This has already added impetus to the "populist" style of American politics and is being felt by regulatory agencies and others. There is something of a paradox here. One would expect with increased levels of education to find an increased level of political participation. On the other hand, the more educated are less willing to accept the old political saws and shibboleths. There is also the sobering fact that increasing numbers of people view politics as dirty.

Decline in Satisfaction. The quality of life expectation has risen rapidly since the Second World War, but the level of satisfaction with that quality of life has not. The increase in affluence has not resulted in an increase in "happiness." Other sections of this paper will also indicate the extent of the general foreboding malaise in which many millions of Americans find themselves. There is widespread discontent with all aspects of life in the midst of increased affluence and unparalleled wealth.

Conflicts Between Individuality and Need For Group Action.

Loss of Individuality in the Marketplace. American culture has traditionally put great emphasis on the value of individuality. The typical folk heroes from Miles Standish to Shaft have been rugged individualists. As a culture, America has frowned upon group, collective, or communal efforts and actions. For example, take the antagonism to "cooperatives," even though they were a form of organization which contributed a great deal to the first century of the nation's progress. In other parts of the world, communal effort or "socialization" has been a way of life for centuries. With the continued growth of population and the complexity and compression of urbanization, the pressure toward "socialization" has also increased. A crucial point where individuality and socialization are conflicting is at the point of employment.

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*C. Bird, *The Case Against College* (N.Y.: McKay, 1975).

Two critical facts of the employment picture in the U.S. are: (1) automation, and (2) a labor shortage in the midst of an umemployment crisis. Automation has meant the slow but continuous elimination of thousands of unskilled and semiskilled jobs. Simultaneously, it has meant an increase in the number of boring, frustrating, materials-handling situations wherein the worker is simply the extension of the machine which is being fed.* It has also meant the appearance, within a short period of time, of many new sophisticated positions at a high level, requiring both training and experience in specialized skills. The best example of such positions is in the electronics and EDP industries. Such skills tend not only to be industry-specific, but require particular knowledge of the management information system or production programming within that industry and within a unique department.

The trade unionist movement in the U.S. has been very unsuccessful in organizing these new information and electronics-related skilled trades. One reason is that they are part of the middle and traditionally conservative, entrepreneurial grouping and are therefore resistant to any sort of collective or communal activity. A specter of change has appeared in the frequency of white collar strikes which have already involved school teachers, government workers, and postal employees. The gnawing fear of being forced out on the street too early for comfortable retirement is making inroads where the old adages for unionization fell on deaf ears.

> "Perhaps it is this specter that most haunts working men and women: the planned obsolescence of people that is of a piece with the planned obsolescence of the things they make. Or sell. It is perhaps this fear of no longer being needed in a world of needless things that most clearly spells out the unnaturalness, the surreality of much that is called work today."**

The effect of this loss of personal estimation of worth has lowered production and quality standards as well as depressed the sense of job satisfaction of many workers in a variety of industries. Many younger workers have despaired of finding any other satisfactions or securities on a job and simply define all aspects of labor in terms of cash payment. Transportation industries certainly suffer from this trend as much as any North American business organization. Steps must be taken to mitigate the future impact of such despair.

Individual Performance and Affirmative Action. The recent introduction of employment and admission quotas based on sex, race, and national origin, and enforced by the federal government has severely

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*W. Kornblum, *Blue Collar Community* (Chicago: University of Chicago Press, 1974).

**S. Terkel, *Working* (N.Y.: Pantheon, 1974), pp. xviii.

damaged the traditional value of individual performance. Beginning with the feminist insistence that university faculties have a sufficient number of women in policy-making positions, the requirement for quota hiring and promotion has been advocated by most other minority groups.* The severity of the antagonism with which such programs conflict with the clear mandates of the Constitution has not yet surfaced. The suppositions at the root of such social justification schemes bring about the most unacceptable of euphemistic behavior. Institutions, which insist on their origins in the American liberal tradition which began with Jane Addams at the turn of the century, will demand "equal opportunity" employment, which is little more than an appeal for preferential treatment on the basis of race or sex. The justification for this interpretation of the American ethic is the idea of "correcting" the abuses of the past. Recent cliometric studies at a number of locations show that the abuses of the past may not have been nearly as severe as those which result from proposals to correct them. Although the Supreme Court has consistently refused to face this extremely controversial issue by hearing crucial cases, it will have to make some definitive decision on the matter. The ramifications of that decision will have far-reaching consequences for employment in the U.S.

A potential difficulty of this forced advantage policy is that it may, in the long run, retard the process of racial and economic integration. In many areas of the country, it has caused severe racial animosity and has meant that industries have moved out further from cities to be less accessible to minority individuals. Other industries have simply erected nominal positions with no real policy-making substance in areas such as personnel and customer relations where women and Blacks can have managerial titles without really affecting the organization of the company.

Conformity and Control of Behavior. One of the less fortunate aspects of new technology is that there is little effective restraint, such that what is possible generally is accomplished. The greatest single instance of such determinism in the 20th Century is the invention and use of atomic weapons. This may be exceeded by genetic and cytological manipulation. In the psychological realm also, behavior modification has become widely applied in what are commonly considered severe social maladjustments such as drug addiction, alcoholism and homosexuality. This modification might be attempted through reconditioning the autonomic nervous system by electric or other discomfort or through the use of drugs as psychometric agents.

However, in an attempt to control and enforce what are thought to be beneficial results on an ever-increasing population, other more subtle

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*K. Millet, *Token Learning: A Study of Women's Higher Education in America* (N.Y.: NOW Press, 1968). Based on position papers produced by the Women's Liberation Group of Columbia University in the early 1960s.

means are being employed by industries and governments all around the world. Psychological pressure can be brought through denial of a certain advantage, let us say education, or employment, to all those who do not conform to some desired pattern. Needless to say, the potential for abuse is horrendous. It has been assumed by too many scientists that the aseptic, abstract quality of computerized data somehow imputes an objectivity and a certainty to the results of their research which transcends the imprecise and messy world of human events. This has caused many persons to become wary of all expert opinions involving the behavioral sciences and human activities.

In the United States, as elsewhere, major experiments have been undertaken with the expenditures of billions of dollars, e.g., the War on Poverty, the elimination of *de facto* segregation in the schools, and the massive federal housing program. Whenever popular support becomes hard to enlist or citizen apathy is in danger of destroying the program, reverse public relations are employed to attempt to instill the desired positive motive.

At the personal and individual level, motivational psychology is utilized for all sorts of purposes in and out of government. The initial steps are taken by the American public school system while the subjects are between four and six years of age. Unfortunately, a good bit of any individual child's success in the school experience and thus his or her chance for "success" is related to how well that child fits into the organizational system. This programming is carried out all through life. American media advertising is dependent on this programming.

One of the greatest and most enduring of social protests carried on during the post-Second World War period has been for the right or respect of individual behavior. Beginning with the Black and then women's social protests, there have been many other groups that have taken up this issue. While these groups are obviously visible and highly vocal, the same feeling of being "pushed around" or controlled has been voiced by millions of other Americans.

Since mass transit involves a high degree of group action, it is unlikely that it will be easily achieved in the face of the traditional ethic of individualism. In the countries where mass transit has become a large-scale success, Japan, Switzerland, Germany, and the Benelux states, group action or "socialization" is much further developed than in the U.S. There is still a deep-seated class consciousness associated with travel modes which is ultimately based upon the notion of individuality and thus nonconformity.* In the popular mind as determined by mass culture, e.g., movies, T.V. etc., the wealthy classes transport themselves in private motor cars or jet aircraft. The middle classes use train as well as plane. However, the lower classes must relinquish their right to individuality and privacy and utilize bus transportation.

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*H. M. McLuhan, *The Mechanical Bride* (N.Y.: Beacon, 1967).

Automation of Information and Judgmental Function. No other modern innovation has so adversely affected the sense of individuality as has the application of the computer. The bigness of corporations, organizations, and governmental jurisdictions is brought home to the average citizen with devastating and frustrating force by the impersonality of electronic data processing. The individual becomes disoriented and confounded when dealing with a faceless, emotionless machine. The living human core of the organization is lost and two-way communication becomes impossible. The situation is made worse by the enormous economies of scale that the computer and electronic word processing provide. These economies are of such magnitude that it is virtually impossible for a large company or jurisdiction to operate in any other fashion than with automated information-handling procedures.*

The replacement of one's identity by a coded number or series of dark bars is enough of an emotional affront. The substitution of electromechanical logic for human judgment is an even more traumatic experience. Basic decisions which result in the inclusion or exclusion of applicants for jobs, students for advanced education, recipients for loans, and the other components of the largess of modern society, are being made, so it is felt by many, by computers without human intervention. The computer, furthermore, is the perfect "fall guy"; all errors and difficulties are passed off as the fault of the faceless machine. This tendency will become more commonplace as the population grows larger. A contributing factor may derive from the circumstance that personal judgments by administrators, personnel officers, and educators are more and more vulnerable to legal challenge.

Since the founding of the republic, the notion of individualism has been a cherished concept in American life. Collective action has never appealed to the ethical fancy of Americans and has usually been equated with socialization, a concept almost universally abhorred in American history. Within the last 30 years, as the frontiers of the U.S. have closed and networks of communication and organizational structure have grown up in every field of human endeavor, it has become increasingly clear that social control is inevitable to avoid the exercise of one person's "rights" from interfering with those of another. Along with this concern has come, almost simultaneously, the notion of the inherent success of science. This has been labeled by H. Th. Dooyeveerd and other legal scholars as "the science ideal."** The obvious conclusion is that through the scientific application of certain principles, absolute social equality could be approached, if not achieved. The price to be paid for this sort of social engineering is an immense loss of personal choice

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*A. Neier, *Dossier: The Secret Files They Keep on You* (N.Y.: Stein and Day, 1975); W. H. Ware, "Computer Privacy and Computer Security," *Bulletin of ASIS*, Vol. 1, No. 3, October 1974, pp. 9, 32.

**H. Th. Dooyeveerd, *The New Critique of Theoretical Thought*, Vol. 2 (Amsterdam: J. H. Kole, 1962).

and discretion. The older a person, the more categorized he or she becomes. The net result is a deep-seated conflict in American attitudes; on the one hand, there is pressure for being an individual, "do your own thing"; while on the other hand, there is the ever-increasing determinism and control based on societal well-being.*

A new class of professionals may arise in the U.S. The only function of this group would be to insulate the individual from the psychic shock of being controlled by his information environment. The incredible reliance on mental health professionals which is now common in urban centers is indication enough that such a class of psychic insulators is making its appearance.

Changes in Work Behavior. The increase in wages and education available to a majority of industrial and office workers in the developed countries has led to a new interest and pressure for improved working conditions and fringe benefits. In the United States, there has been a decline in union membership but no decline in the hold of the unions over the closed-shop industries.

Aside from the traditional labor-management adversary relationship, there is also a strong movement toward increased humanization of the work environment. American workers have been buffeted by repeated layoffs and steady erosion of purchasing power. Many have sought increased control over their own economic destinies. One definite step is to gain a voice in policy-making and personnel practices. Another, of course, involves getting a "piece of the action."

The New Role of Women in Work. The legal structure of the United States regarding work has been changed profoundly by the efforts of feminist groups. As a heritage of the last century, many states and other jurisdictions had laws on their books which subordinated female workers on account of their sex to their male counterparts. The impetus which pushed the American women into the job market was the labor shortage brought on by war.

In both the First and Second World Wars, there were strong pressures for women to replace those in the Armed Forces. In 1940, only 27.4% of American women worked outside of the home for wages. This rose to 35% in 1944 and dropped again to 29.8% in 1947. From 1965 to 1975, there has been a steady increase until somewhere around 47% of American women now work.** However, their distribution throughout the labor force is still

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*H. Van Riessen, *DeMaatschappij Der Toekomist*, Franeker, T. Wever (1952) pp. 176-201.

**U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics* (1974).

toward the lower end of the wage/responsibility scale. While there were 14 million male professional and managerial workers employed in the U.S. in April 1974, there were only six million women in a similar position. The difference in wages was even more acute, with the average female wage being 20% to 50% below the male wage for the same job with identical responsibilities.

The biggest obstacle to long-term career commitments by women is, of course, the requirement of childbearing. In the foreseeable future, there may be broader legal structures allowing women to take leaves of absence or temporary health compensation so that they could bear children. The difficulty will be that such an exception concerning attendance at a place and time of employment will put strain on traditional concepts of the masculine role in employment.

The Minority Position in Industry. Starting with the Civil Rights Act of 1964, there has been a long series of court challenges and decisions affecting the place of the various minorities in the labor force. The minorities thus cited have been those with the most difficulty gaining a position in the economic middle class. Black Americans, numbering about 24 million, have successfully won virtually all of the rights granted any other group of American citizens. Certain other racial and ethnic minorities including Spanish-Americans, Puerto Ricans, American Indians, and Eskimos have followed the lead of the Blacks in demonstrating and bringing court suits for their rights. Even though the Blacks have won political and social gains, they are still far behind the whites in regard to income. While the average weekly earnings of white males (in current dollars) for 1973 was $146, the same figure for Black males was $97.* As inflation and other economic constraints become greater, it is possible that Black economic and social groups will press more vigorously for relief from this disparity in incomes.

Bifurcation of Urban and Mid-American Cultures. From 1616 until 1840, America was predominantly an agrarian society. Scholars such as Alexis de Tocqueville (circa 1845) praised this aspect of the U.S. and its citizenry. After the Civil War (1865), the pressure of new immigrants coming to the East Coast forced the longer settled middle and lower economic classes to migrate West. In waves, each group of immigrants succeeded the other. The Scandinavians, Germans, English, and Scotch were followed by the Irish, Italians, Polish, Russians, Central European Jews, and peoples from the Balkans. They were succeeded in turn by the Blacks from the South moving into northern urban centers during and after the First World War, and, finally, by the Puerto Ricans

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*U.S. Bureau of Labor Statistics, *Employment and Earnings Monthly*, December, 1974.

and other Spanish-speaking groups. After 100 years of immigration and internal migrations, a separate social system had developed in the Middle American and Southern states in contrast with the major urban centers of the Northeast and Far West.

In the 1940s and 1950s, a new political alignment arose. The previously middle and upper class Republican Party and the working class and immigrant Democratic Party lost their traditional characteristics. The most overt sign of this melding of political philosophies was the attempt at organizing a left-leaning third party by Henry Wallace in 1948, and the numerous attempts to build a strong conservative third party since. In the intervening years, a new sociopolitical reality has come into being. This divergence is best seen in the two sets of contrasting tendencies shown schematically below:

Urban-Pluralistic Society	Mid-American and Southern Society
Immediate foreign or lower class	Mediate foreign or middle class
Unionist and collectivist	Antiunionist and individualistic
Ethnic and urban culture	Country and western, pop culture
Sexually active	Sexually latent
Interest-group oriented	Social-hierarchial oriented
Self-image: "liberal"	Self-image: "conservative"
Democrat/Liberal Republican	Republican/Conservative Democrat
Socioneurotic	Xenophobic

Although firm data in the area of social indicators are extremely difficult to acquire or interpret,* that this immense bifurcation does exist has been shown by a great many studies. Differences are also found in the social mores and tolerances of the two groups. As an effect of the Vietnam War and the Watergate affair it appears that the two societies may be drifting further and further apart. The most obvious result of this drift is the refusal of the suburban and rural areas to aid or help the financial and social plight of the urban areas.

The geographical distribution of these two sets of world views and cultures is made more difficult to define by virtue of the frequency of interregional migration. However, the urban-pluralistic category appears to be located in the three major industrial corridors: Boston to Washington (BOSWASH) in the East, Evanston-Chicago-Gary (EVANRY) in the Midwest, and San Francisco to San Diego in the West. The California picture is further confused by the proximity of free-form life-styles and right-wing conservatives. Just as there are deep-seated differences between the two large factions, so there is a different set of priorities regarding social problems. While the urban-pluralistic population worries about mass transit, the Mid-American seeks commercial aviation for his town and more, better roads for his car.

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*E. B. Sheldon and R. Parke, "Social Indicators," *Science*, 188, May 16, 1975, pp. 693-699.

One very serious aspect of the difference between these two cultures is the variance of opinion concerning security and individualism. The urban-pluralist dweller, particularly the upper-middle class, will quickly trade a portion of his or her individual right to own, let us say, a gun for the collective security of gun registration and control. The Mid-American cannot see any necessity for such a radical commitment. The result is that regionalization and provincialism within the American system is still too strong to demand any unified effort against common social woes.

Urban Stresses. The overwhelming fact of life in any one of the three urbanized corridors of the U.S. is stress. The individual citizen is continually subjected to irritants, affronts, and sensory shocks. Accident, crime, and life-threatening situations are many times more common in the urban environment than in either the suburban or rural environment.

There are many kinds of affronts against the health of the individual in the urban environment. Many of these are detectable by the senses. Possibly the most evident are air pollution and noise. The condition of the air over any major city varies with the time of year and the meterological conditions; but under any circumstance, it will have from 10 to 100 times the amounts of carbon monoxide, sulphur dioxide, and other pollutants as the air only 100 miles away in open country. Tests have shown the amount of lead from leaded fuels in the blood of street workers to be as high as 0.038 mg/100g.* This is within 50% of the dosage where poisoning occurs. Added to these noxious gases are microscopic grit, carbonized waste, mineral acids, and metallic particles as well as strands of airborne asbestos, nylon, fiberglass, and the like.

Noise pollution has been shown to be the other great destroyer of health and cause of neurologic impairment. One type of auditory impairment is known as PTS (permanent threshold shift); a sound level of 80 dB (decibel) is thought to be the upper limit for total safety from hearing damage.** The typical quiet country road produces approximately 45 dB; the city street, 90dB; the pneumatic jackhammer, a steady 115 dB.

The symptoms of continued exposure to air pollution are bronchial irritations and infections, sinusitis, pneumonia, and emphysema. The symptoms of continued exposure to noise pollution are reduction in the

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*U.S. *Department of Health, Education and Welfare*, Public Health Service publ. #999-AP-12, January, 1965.

**R. R. Coles, G. R. Garinther, D. C. Hodge, and C. G. Rice, *Criteria for Assessing Hearing Damage Risk from Impulse-Noise Exposure*, U.S. Army Tech. Memo 13-67. AMCMS Code 5011.11.84100.

peripheral circulation, build-up of fatty deposits inside the blood vessels, constriction of the iris, excessive tension in the muscles, increased gastric secretion, increased blood pressure, anxiety, nervousness, insomnia, irritability, and antagonism. So pervasive is noise, that unconscious physiological responses to noise stimulations continue during sleep and even under anesthesia.* Many hundreds of thousands of persons living and working in inner-city environments have become accustomed to a continual state of neurosis. They have maladapted their homeostasis to a steady-state which is only a caricature of the normal.**

In a secondary manner, the urban-dweller is affronted by water pollution to such a degree that the only available water is laced with chemical substances ranging from common sodium and potassium salts to picotrace amounts of such radioactive substances as astatine and strontium. The city dweller is also affronted by the health and psychic hazard of mountains of solid waste which at best breed rats, mice, and roaches, and at worst leak partially reduced organic solvents and potentially dangerous hydrocarbons into ground receiving waters.

Perhaps even more damage is done to human beings by the psychological shocks of urban existence. One of these shocks is the effect of visual pollution. This is the continual grating effect of dirty streets, garish billboards, clashing light-patterns and on-rushing traffic. Whereas these sense-jarring affronts used to be centered in the cities, they are now, through the extension of "stripdevelopment," spread all across the American landscape. It is this disregard for aesthetics which has homogenized the American landscape into a disquieting monotony seen nowhere else in the world.*** With nearly one-half million gas stations, fast-food establishments, roadside taprooms, and similar facilities distributed across the country, there is relatively little relief in visual aspect.

There is another more serious side to the problem of psychic shock, and that is the deep-seated concern for personal safety and security in the urban environment. Violent crime in America, spawned in poverty and impelled by drug addiction and alcoholism,† has caused the curtailment or cessation of most necessary services within the inner cities across the U.S. Private physicians, drug stores, grocery stores, delicatessens, and similar establishments have fled the decay of social and legal security.

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*R. T. Wilkinson, "Interaction of Noise with Knowledge of Results and Sleep Deprivation," *Exp. Psychol.* 66, 332, 1963.

**P. Gildston and H. Gildston, "Noise Pollution" in *North American Reference Encyclopedia of Ecology and Pollution* (3rd ed.) W. White, Jr. (ed.) (Philadelphia: 1975) pp. 222-223.

***N. I. Reiger, "Visual Pollution," *JAMA*, January 31, 1972.

†J. M. MacDonald, *The Murderer and His Victim* (Springfield, Ill.: Charles C. Thomas, 1970).

The legal system is on the verge of disintegration and collapse due to the overload of untried cases. The correctional system has proven incapable of rehabilitation; in fact, the concept itself is in jeopardy.

As a result of these affronts, the majority of urban dwellers have retreated into some small collective or group situation for security. While the youth find safety in urban street gangs, their elders find mutual benefit in neighborhood, ethnic, or cultural groupings and shun contact beyond their small boundaries. They have given up individuality for security. Unfortunately, this will not improve the overall functioning of the city or the nation but lead to increased tribalism among the lower socioeconomic class. All this bodes ill for the long-term improvement of life in the urban environment. The remedy which is already being attempted is to pass the cost of renewal on to the suburban and rural populations, as a sort of "price of redemption."

Despite the efforts of the news media, the Mid-American culture and population appear substantially indifferent to the plight of the urban centers. Massive federal rebuilding schemes for urban transit and innumerable other renovations to the urban corridors have repeatedly died in the legislative process. The portion of the population which is least able to achieve economically or socially has been drawn to the cities since 1900. This has produced a hard-core grouping of virtually unemployable persons in the inner city. Here are located racial, ethnic, and disadvantaged subgroups of all types. It is this aspect of the urban migration which has contributed to the current crises in Detroit, Cleveland, and New York, as well as in many of the other urban areas of the U.S. When or how the situation will improve cannot be foreseen at this time.

The Ultimate Problem of Equity -- Who Pays? Some of the social impacts presented here are only indirectly important for intercity transportation planning. Others are crucial. The solutions to many of the problems that beset modern urban life can be approached through long-term planning and the judicious expenditure of money. Unfortunately, there is no one federal, state, or local agency which has demonstrated this capability over the last decade. The various jurisdictions, boards, and agencies have labored for nearly 50 years to turn back the double tide of population and urban stagnation.

The ultimate root of the problem is equity. Under the American system, the federal government is the seat of most large-scale spending. As a result, it is concerned with those problems which have the greatest popular political appeal. The plight of the cities does not fit that category. None of the last six presidents of the United States or their administrations has come from the urban-pluralistic segment of American society. Although they required support from this segment to attain the White House, they have not been overly empathetic to the problems of the urban environment.

The renovation or rehabilitation of any sector of the transportation system or its real estate involves enormous monetary expenditures, usually estimated in the billions of dollars. The example of the current problems of the railroads in the Northeast is a case in point. As complex as are the problems confronting the rail system, the problems of the City of Detroit, or New York City, or public education in rural America are as complex or more so.

In the case of these and similar problems, the crucial question is: Who pays? The current system of taxation rests most heavily upon the wage-earning middle class, both blue collar and white collar. The shrinkage in semiskilled and skilled jobs has resulted in regressive labor practices by unions and closed shops in many industries. This means that the taxes of the middle class are being used to bring and keep a large number of persons in the middle class by a kind of social agreement rather than the market value of their labor.

Akin to this difficulty is the continuing rise in the cost of money itself. While a relatively small number of banks, insurance companies, and conglomerates control a lion's share of the available capital, they in turn, are subsidized in a great many ways through federal charters, federal R&D expenditures, or federal contracts. The result is that the taxes of the middle classes are used to help the money vendors maintain their advantaged position.

Implications for Intercity Transportation

Although it is extremely difficult to assess the priority of one social issue over another, and it is impossible to quantify the degree of impact that any one social issue may make, some of the immediate implications and most likely outcomes can be outlined. The two general areas of impact involve, first, what may be characterized as the nonmonetary aspects of the demand for transportation; and, second, the societal background within which governance is exercised. The strength of the effects of these implications is not yet apparent, and the final form of their results will not be clear for many years to come. They are, however, vitally important considerations for transportation planning looking to the year 2025.

The Nonmonetary Aspects of Transportation Demand. A number of contributory factors have led to the current high level of expectations regarding travel on the part of the American population. The federal government itself was the institution which initiated the vogue for air travel by dispatching so many millions of citizens around the U.S. and around the world. Air travel, both military and civilian, came into its own as a direct result of World War II. The pattern of behavior was translated into civilian demand as soon as the War was ended and has been growing ever since.

The glamour and allure of travel was enhanced by its constant usage in films, radio and TV advertising, and drama. It has become a pervasive theme in popular culture, and easy and accessible travel by manifold means has become instilled in the American consciousness.

The high level of expectation for both domestic and foreign travel was met by an aggressive and growing airline industry. Student fares, family fares, group and charter fares, and all sorts of special marketing approaches were tried with evident success. This ability to travel was quickly interpreted to involve all of the other personal changes in mores and customs. The "jet set," the "airport romance," and the supposed sexual liberty of stewardesses came into being. All of these manifold impressions reinforced the growing desire to travel.

By some strange phenomenon, possibly peculiar to Americans, this *desire to travel* has become transformed into a perception of the *right to travel*. This perception is already being expressed by women's and ethnic minority groups. These organizations are demanding the bases of wide-ranging travel, such as credit cards, favorable rates, and the like. A special case of this perception has arisen very recently in the demand by the elderly and the physically handicapped that they be provided with low-cost fares and mechanical and other required equipment to allow them the same freedom of access to travel as the general public. It is clear that government jurisdictions and regulatory agencies will be hard put to refuse their demands on the basis of compensatory actions already taken with regard to minorities in other areas of society.

The accommodation of such demands, of course, costs money. The couching of such demands in terms of "human rights," as in the case of the host of other rights of citizenship, will tend to force consideration in egalitarian and noneconomic terms. The net result may be a substantial cost overburden, imposed on all travelers, to accommodate the few. The situation is entirely analagous to that concerning the Clean Air Act amendments in which all automobile owners are expected to bear the costs required to meet the needs of the Los Angeles basin and a few other major cities.

Even more important than the positive inroads of demands for increased availability and ease of travel are the negative implications. It is clear that any attempt by government, no matter how high-minded the motivation, that seeks to curtail or limit the direction, accessibility, or ease of travel on various modes, will be met with stiff and large-scale opposition from a broad section of the population. The notion of the "right to travel" will not be easily thwarted, such that any efforts to prescribe when, where, or how one should travel will meet strong opposition.

One particularly intransigent problem which is the subject of general traveler concern is the transportation interface, the major source of transportation system inefficiency. The specifics include inconvenient or nonexistent parking facilities around airports and train stations;

slow or intermittent service on ground carriers from airport to downtown areas; substandard, low-security terminals at interfaces between air and rail, or rail and bus transport systems.

The Societal Context of the Government Mandate. Any governmental jurisdiction must keep in contact with its constituents. It makes no difference whether it is a township supervisor or a United States senator. The representative in government must continually "read" the mood of the electorate. As the 50-year period of this overview progresses, representatives at every level must be sensitive to the changing opinions of the populace. The very nature of the anti-big-business feeling is such that it will not generally volunteer its vehemence to constituted authority.

The informed electorate of today is quickly developing into the even better informed electorate of tomorrow. The old excuses and regional platitudes will no longer suffice to justify governmental actions and certainly will not be admissable as defenses for abuse of that authority. The momentous task of rebuilding public confidence awaits federal and state governments. It is best begun before a large minority of disenchanted citizens becomes a majority.

As much as this minority distrusts government, it distrusts big business even more. The depth and strength of the anti-business sentiment is not perceived by many business leaders. The federal government has already correctly perceived that the electorate will give it the mandate to correct abuses in the business segment. The results of this will be more and further-ranging government regulation; regulation not only over the specific operations of the business in the marketplace, but also over many of the aspects of its internal operations as well. Business hiring and firing practices, wage increases, stock options, and health and safety programs must all be sufficiently well-organized and documented to withstand the inspection of regulatory agencies. The public mistrust of corporate enterprise has reached the stage that a certain vindictiveness is evident. The social interest sector will ignore its own economic best interest to demand "justice" by federal intervention.

This control and intervention will not stop at the federal level, but will penetrate even to the local level. Some local jurisdictions already have a voice in the control and operations of locally situated industries. They are particularly concerned with taxation, environment, and job opportunities, all of which are at the heart of corporate planning and decision-making. The problem of jurisdictional autonomy will become more acute, and corporate and business institutions will be the battleground over which it is fought.

Transportation systems will have to be planned in such a fashion that they can allow and provide an increasing degree of local self-determination. This is in direct contradiction to many of the schemes currently being considered and the need for systemwide integrity. The success of

any long-term transportation system investment is directly related to its acceptance and use by the public. The opinions and the fears of the populace, whether judged rational or irrational, must be given serious credence for the enterprise to be successful. What must evolve, then, is some mechanism for assuring a high degree of local or regional control of implementation within the context of federally established policy and rational coordination. It is clear that some intercity transportation issues are properly addressed at the federal level, others at a regional or state level. What is not clear is how or whether such issues can be addressed rationally in a divided and emotionally charged political arena.

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XV. THE TRANSPORTATION/COMMUNICATION TRADE-OFF

by

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ABSTRACT

The next generation of telecommunication technologies will offer audio, video, and data communication capabilities that allow managers and professionals to talk with several remotely located individuals simultaneously; to transmit and receive document facsimile copies in seconds; to transmit and receive motionless pictures of drawings, contracts, X-rays, or blackboards; to transmit and receive video pictures of remotely located persons or groups; to compose and edit documents simultaneously and interactively with remotely located individuals; and to access and retrieve remotely located computer-stored data.

The capabilities have generated speculation that new communication technologies will reduce travel by substituting electronic interaction for face-to-face meetings. More thoughtful analysts expect the elimination of some trips, the postponement or reorganization of other trips and itineraries, and the development and sustenance of more extensive social networks that induce travel.

Research efforts to date have not produced a predictive model of the interaction between communication and transportation that incorporates travel substitution, displacement, supplementation, and inducement. The behavioral, attitudinal, and situational nuances of consumer choices between currently available communication and transportation services remain largely unknown.

In the absence of a persuasive model of transportation/communication interaction, futurists have simply assumed a trade-off comparable to the choice between travel modes. A rival hypothesis that communications capabilities stimulate travel by enhancing our opportunities to sustain and update a social/transactional network that is larger in terms of both membership and spatial reach, leads to reasonable predictions of a net increase in travel demand, which is consistent with trends in corporate organizational size such as multinationalism and vertical and horizontal integration.

Without a model, current research has focused on trip characteristics deemed to be prone to communication substitution by an intuitively established consensus. A recent Canadian study's questioning of the assumption of telecommunications as a replacement for, rather than as a supplement to, travel indicates the need to test assumptions thoroughly before estimating impacts on travel and the need to conduct basic behavioral research on travel/communications interactions.

Certain predictions remain intact. New communications technology will significantly enhance the quality of communications in the 1980s and beyond, will provide the opportunity to eliminate or defer some travel, and will allow some firms to increase the reach and efficiency of their operations, and therefore, the opportunity or requirement for travel.

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Communication substitutions will probably include: video demonstrations in place of sales calls; training and retraining using video and interactive computers; routine appointments involving collegial information exchange but not high-risk negotiation; and briefings and presentations of relatively short duration.

In short, credible projections of the net impact of new communication technology on travel demand and actual travel behavior are premature in light of our current understanding of the interaction between face-to-face and mediated transactions.

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XV. THE TRANSPORTATION/COMMUNICATION TRADE-OFF

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The next generation of telecommunication technologies will offer broadband audio, video, and data communication capabilities that closely approximate the information-exchange capability of face-to-face interaction. The forebears of this new communication capability include such on-the-shelf technologies as videophone, video cassettes, conference telephone arrangements, computer terminals, and telefax.

Next generation technologies will enhance the ability of managers and professionals to:

- Talk to several individuals at remote locations at the same time
- Transmit and receive facsimile copies of documents in a matter of seconds
- Transmit and receive motionless pictures of drawings, contracts, X-rays, or blackboards
- Transmit and receive video pictures of persons or groups at remote locations
- Compose and edit documents simultaneously and interactively with individuals at remote locations
- Access and retrieve computer-stored data from remote locations.

These capabilities have generated enthusiastic speculation that new communication technologies will reduce travel by substituting electronic interaction for face-to-face meetings. More thoughtful analysts expect communication technologies to allow the elimination of some trips, encourage the postponement or reorganization of other trips and trip itineraries, and permit the development and sustenance of more extensive social networks that, in turn, induce travel.

Research on Effects of New Communications Technology on Travel

Research efforts to determine the net impact of the so-called transportation/communication trade-off on travel have followed three paths: surveys of potential communication users, cost comparisons, and estimates of the upper-bound limit of substitution-prone travel based on the match between current trip characteristics and communication capability.

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None of these paths has produced anything approaching a predictive model of travel substitution, displacement, supplementation, and inducement. The behavioral, attitudinal, and situational nuances of consumer choices between currently available communication and transportation services remain largely unknown. We do not know, for example, the net impact on travel of postal service or the near-universal diffusion of the telephone. We do know that the travel and communication requirements of firms in the information and transaction sectors of the economy have increased in tandem. We also know that these sectors of the economy are growing faster than basic industry and even personal services.

In the absence of a persuasive model of transportation/communication interaction, futurists have assumed the existence of a trade-off comparable to the choice between travel modes. This simplification of the research problem has produced a number of polemical inquiries intended to demonstrate the social and environmental benefits of travel substitution and the high quality of interaction obtainable from electronically mediated communication. These studies have generally ignored a rival hypothesis: communication capabilities will stimulate travel by enhancing our opportunities to sustain and update a social/transactional network that is larger in terms of both membership and spatial reach. Viewing communication as a supplement rather than a surrogate for trip-making can lead to reasonable predictions of a *net increase* in travel demand. The net-increase hypothesis seems to be consistent with trends in the size of corporate organizations such as multinationalism and both vertical and horizontal integration. If enhanced communication increases the reach and efficiency of large, spatially-diffuse organizations, it seems reasonable to expect some correlative increase in travel for site visits and high-risk negotiations. This prospect has been ignored by most communication futurists.

In the absence of a model of transportation/communication interaction, current research has focused on the characteristics of trips that might be prone to communication substitution. The technical literature reflects an intuitively-established consensus that some trip types are more susceptible to substitution than others. "Substitution-prone" trips have been categorized in terms of trip purpose, trip-end activities, and the trip-maker's occupational and personal characteristics.

These expectations can be charted as follows.

	SOME LIKELIHOOD OF SUBSTITUTION	LOW LIKELIHOOD OF SUBSTITUTION
TRIP PURPOSE:	Business and conventions	Visit friends and relatives
		Outdoor recreation
		Sightseeing and entertainment
		Mixed business and leisure trips
TRIP-END ACTIVITY DESCRIPTORS:	Routine contact with familiar persons	Exploratory contact with unfamiliar persons
	Low-risk negotiations; passive observation	High-risk negotiations, active participation
	Exchange of data, ideas, and documents	Demonstration or use of equipment; site visits
	One-to-one meetings	Group meetings
	Speeches or lectures (one to many)	Seminars and team workshops
	Brief appointments	Extended, multihour meetings
	One-day, sparse-calendar trips	Multiple-day, multimeeting trips
	One-destination trips	Multileg, multidestination trips
TRIP MAKER CHARACTERISTICS:	Does not enjoy travel	Enjoys travel
	Controls travel choice	Scheduled by organizational superior
	Professional, technical, or managerial status; sales or sales engineering	Service, clerical, or blue-collar employment

These expectations have been stated as hypothesis and tested by a Bell Canada research team using survey methods.* Kollen and Garwood surveyed 10,000 Canadian air, bus, rail, and auto travelers, securing information on trip purpose, trip-end activity, and traveler demographics. They also asked the respondents whether they would have made the trip-in-progress if the communication capability described on page one of this issue paper had been available to them.

Twenty percent of the Canadian respondents indicated that they would *not* have made the trip if a communication alternative were available. However, the Bell Canada research group was not able to establish strong correlations between trip or traveler characteristics and the inclination to use communication substitutes. The inclination to substitute correlated most strongly with the travelers' attitude toward the proposed technology--not the trip-end descriptors. Kollen and Garwood reported that "the analysis offers little support for hypotheses which attempt to distinguish substituters from non-substituters." They concluded that "the present study offers little support for hypotheses concerning the *replacement* of travel by telecommunications" and that "the lack of explanatory power may also indicate that conceptualizing substitution of telecommunications as a *replacement process* rather than as a *supplement* to travel is ill-conceived."

The Canadian research group's cautious conclusion still indicates that transportation/communication trade-off researchers will have to test their assumptions thoroughly before we can accept the validity of enthusiastic estimates of the travel that can be replaced or displaced by communication technology.

Conclusion

These let's-start-all-over-again findings establish the need for basic behavioral research on the interaction between travel and communication. They virtually dismantle earlier conclusions reached on the basis of small-sample or case-study research, leaving communication futurists with some very spartan and highly qualitative predictions intact:

1. New communication technology will significantly enhance the quality of *communication* in the 1980s and beyond.

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*James H. Kollen and John Garwood, "Replacement of Travel by Telecommunications," Business Planning Paper #29, H. Q. Planning Department, Bell Canada, Montreal, 1974.

2. New communication technology will provide the opportunity to eliminate or defer some travel--20% is a reasonable bet.

3. New communication technology will allow some firms to increase the reach and efficiency of their operations--increasing either the opportunity or requirement for travel.

The communications substitutions will probably include:

- Video demonstrations in the place of sales calls
- Training and retraining using video and interactive computers
- Routine appointments involving collegial information exchange rather than high-risk negotiation
- Briefings and presentations of relatively short duration

We must conclude that credible projections of the net impact of new communication technology on travel demand and actual travel behavior are premature in light of our current understanding of the interaction between face-to-face and mediated transactions.

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XVI. A NOTE ON TECHNOLOGY PESSIMISM

by

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XVI. A NOTE ON TECHNOLOGY PESSIMISM

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This note is motivated by a remark by the author in a discussion of the future of intercity transportation, "Given present conditions, the outlook for increased [technological] efficiency is modest other than in air transportation."* The author feels his remark is too pessimistic, and this note explores the reasons for pessimism about technology.

Technology pessimism appears in many circumstances. There are those who do not believe that technology will continue to provide solutions for food, pollution, energy, and other problems. These matters raise serious questions and are the subject of much current debate (e.g., see recent issues of *Science*). They are not to be dismissed lightly.

However, concern in this note is less with global issues; it is with our seeming inability to forecast the evolution of specific technologies using a forecasting horizon of several decades. Such technology forecasts have been undertaken in this study of intercity transportation in an effort to help define feasible futures for related transportation systems. As Jantsch has pointed out, these futures must be reachable through feasible paths.** Do such paths exist and, if so, are they feasible from social, *technology*, resource, and other points of view? When attempting to answer this question, why is there pessimism about technology?

The widespread tendency to miss the mark in technology forecasting has lead Arthur Clarke to formulate what he terms Clarke's Law: "When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is almost certainly wrong."*** And Clark lays the erroneous predictions to either a failure of imagination or a failure of nerve. The view in this note is that failures mainly result from lack of appreciation of the technology development and implementation processes, and these processes will be explored for causes of forecasting failures.

The processes, as is well known, are research, development, and implementation activities based on knowledge and markets. The predominance of the energy expended in these processes occurs when marketing or implementation is undertaken. Implementation involves development and shakedown of prototypes, trials, revisions, and the winning of clients

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*W. Garrison, "Current and Future Forms of Intercity Passenger Transportation," an issue paper in this report.
**Erich Jantsch, "The New Testament," *Futures*, 3 (1971), pp. 68-72.
***A. Clarke, quoted in *Time*, February 15, 1971, p. 38.

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and sponsors for the product. The processes work best where innovative and highly motivated actors are involved who hold views apart from those of their peers, as Morison has shown.* Often, the stage for these actors is the small, risk-bearing firm. One pattern for technology is that it substitutes for some process when it offers efficiency. Subsequently, the technology is improved by orders of magnitude and by changes in the environment within which it is imbedded. On the other hand, instances can be cited in which the substitution technology had little effect upon the larger task and the impacts were small. The workings of these processes in transportation,** urban systems, and computers*** have been discussed by the author elsewhere.

It is speculated here that the pessimism phenomenon arises from failures to read the technology processes at several points. An important instance is the misreading of the client, "the market is so-and-so, therefore it will always be so." This was certainly the case in computers, where it was estimated that the market would never be larger than that for half a dozen machines. New markets may be formed, and the technology assessment problem is very much that of trying to understand new markets and activities implied by these new markets.

Failure to understand the market may have been part of Dean's problem (the quotations used here and below are from a collection by Gamarra†):

> "You could put in this room [his office], de Forest, all the radiotelephone apparatus that the country will ever need."
> W. W. Dean, president of Dean Telephone Co., 1907

It certainly would have been a problem if a technology assessment had been made of the automobile, for in its early days it was marketed mainly as a novelty.

Another cause of failures might be the reading of the technology development and implementation process too closely. This seemingly leads in two directions. Persons involved in the process are very sensitive to the great effort required for marginal improvements in the technology and the penetration of markets. Through years of experience, they develop a calculus that gives them great insight into the market and technology frontiers as they have experienced them. Their calculus fails whenever any of its implicit ground rules are broken. This may have been Furnas' problem:

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*E. Morison, *Man and Machines*, M.I.T. Press.

**W. Garrison, "Transportation Systems Invention and Innovation," *Proceedings*, Intersociety Conference on Transportation, 1972, pp. 101-109, *SAE Paper* 720556.

***_____, "Computer Technology, Urban Processes and Problems, New Futures for Urban Areas," *Bulletin*, World Future Society, 3 (1970), pp. 1-15.

†N. Gamarra, *Chemical and Engineering News*, August 11, 1969, p. 68.

"What the ultimate attainable speed (of airplanes) may be one would not care to guess but it might well approach 500 miles per hour, and certainly 350 miles per hour for transport planes at the higher altitudes is not an unreasonable figure to expect within a few years."
C. C. Furnas, American chemical engineer and educator, 1936

Furnas knew his processes so well that his calculus gave him a clear view of its margins.

A variant is that a group involved in a technology may be limited by its span of knowledge; they may be unaware of other technologies that may invade their territories and supersede them; perhaps this was Leahy's problem:

"That is the biggest fool thing we have ever done. The (atomic) bomb will never go off, and I speak as an expert in explosives."
Admiral William Leahy, 1945

An associated matter is that of the relation of a new technology to an extant peer group. The peer group in producing and marketing a technology has its values and behavior mannerisms tied up in that process. Some change that would shock that process is simply unthinkable. This was probably part of Leahy's problem and Woodward's problem:

"As far as sinking a ship with a bomb is concerned, you just can't do it."
Rear-Admiral Clark Woodward, 1939

In transportation, the unthinkable has been evidence in some of the highway communities' views of mass transit and in the rail transportation view of diesel locomotives.

It is very often the case that the arguments supporting technology pessimism are couched in technological terms, "it cannot be done." This is not surprising because this is the language of the technologist, and his most powerful arguments turn on the physical principles. Thus, Symonds argued that screw propellers would not work, and Chanute explained that airplanes will always be small:

". . . even if the (screw) propeller had the power of propelling a . . . vessel, it would be found altogether useless in practice, because the power being applied in the stern it would be absolutely impossible to make the vessel steer.
Sir William Symonds, Surveyor of the British Navy, 1837

"(Airplanes) will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must

remain small and the passengers few, because the weight will, for the same design, increase as the cube of the dimensions, while the supporting surfaces will only increase as the square."

Octave Chanute, American aviation pioneer, 1904

The above illustrates why things might go wrong, and it is not a constructive discussion of what to do to guard against errors. It could be if each of the above observations was cast in a "Thou Shall Not" framework, but because that is simply a matter of rewording, it will not be undertaken here.

XVII. THE EFFECTS OF EXISTING CAPITAL STOCKS ON TECHNOLOGY ASSESSMENTS

by

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ABSTRACT

This paper demonstrates that capital stock is an important determinant of technological possibilities because of the inertia inherent in an existing stock of assets. The implication is that future possibilities are preconditioned by past investments. Therefore, a technology assessment must take into account changes in the existing stocks of capital that are needed to facilitate a projected technological innovation.

Capital, by definition, is a resource with a significant lifetime. The period over which the asset provides a usable output flow is an important dimension of capital stock. This concept, known as "service life," has different connotations for economists, engineers, accountants, technologists, and internal revenue service agents. A multiyear service life means that an enterprise has a capital stock of a given type of technology; this investment constitutes "sunk costs" in fixed assets.

Sunk costs, such as those inherent in transportation equipment and infrastructure, are important in shaping future investment policy, because any commitment to a particular technology requires compatibility with the existing capital stock, which, in part, explains why standardization of products is such an important issue in many industries. Compatibility of new technology with existing capital is important because it may necessitate investments to add support facilities, to interface new technology with existing capital stock, or to upgrade existing capital stocks to a higher level of performance matching the new technology. These investment costs should be considered part of any technology decision because the efficiency of the overall system, as well as of the new technology, can be lowered by incompatibility of various capital stocks.

As a result, sunk costs can impede flexibility in technological planning; however, investments in long-lived assets do not necessarily preclude replacement of capital, if the resale market is liquid. Sunk costs raise the risks in decisions to shift the technology complexion of the capital stock. One such risk facing managers of publicly funded enterprises is the political consequences of projects into ill-fated technology; such a risk is an impediment to the pursuit of radical innovations.

Associated with an existing capital stock are demand-related factors many of which are externalities to the technology decision. Idle capacity, changes in land use patterns, or imposition of extraordinary and nonrecoverable economic gains or losses are all externalities likely to arouse vociferous reaction by affected parties. Imposition of changes in traditional patterns of investment and technology must, therefore, be tempered by recognition of dislocation among both users and nonusers.

On the supply side of transport, government policy priorities (for example, foreign trade and international factors) sometimes impose constraints

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on technologies which are available to alter the existing capital stock. Raw material supplies from abroad, balance of payment considerations, tariff restrictions, and foreign policy objectives can direct changes in technology.

Another supply-related impediment to utilization of a new technology is an overwhelming commitment to a singular technology. In short, past investment policies have influenced the direction of technology change. And, demand and supply factors reinforce the argument that capital stocks do influence technology shift.

Investment experiences of AMTRAK clearly indicate that the existing capital stock fundamentally affects technology changes in intercity rail passenger transport, and sunk costs in equipment and infrastructure strongly shape the direction of technology activities.

AMTRAK also exemplifies ways in which demand factors are important to future investment decisions. For example, the specifications for performance of new equipment are warranted so as to procure cars and locomotives that stimulate additional ridership.

Supply-side factors constrain AMTRAK as well, where for example, the threshold size of an order needed for equipment procurement must be large enough to achieve economies of scale. Also on the supply side, AMTRAK investment policy has a built-in bias toward labor-saving technologies since capital funds are grants.

Because air carrier regulation largely prohibits price competition, airlines resort to extensive competition in quality and quantity of service. Airframe reequipping cycles are made economically feasible by the liquidity of the used aircraft market.

However, changes in aircraft technology and design have precipitated changes in techniques and design in the interface between the terminal building and the aircraft.

Changing land use patterns and worsened congestion at hubs may increase the demand for service to satellite airports. Intermodalism may encourage development of satellites, contingent upon technological developments in short takeoff and landing (STOL) and quiet takeoff and landing (QTOL) aircraft. Civil Aeronautics Board and Federal Aviation Administration regulations can also be an inducement to decentralize metropolitan air service.

Because planners are increasingly compelled to seek ways to prolong the service life of the existing capital stocks of land, access facilities, runways, terminal buildings, and parking facilities, technological innovations aimed at alleviating peak period congestion and cramped facilities will be all the more crucial.

Cross subsidization by equipment manufacturers also influences the directions of technology. Innovations in airplanes, power plants, and avionics have come about, at least in part, as a result of military expenditures.

In air transport, compatibility of existing equipment with new technologies is important to management. Normally, increased homogeneity of an air carrier fleet enables cheaper maintenance through savings in inventories, skills of maintenance personnel, and interchangeability of spares.

The auto system exhibits the highest degree of inertia, technological and otherwise, related to past capital investment decisions. The system consists of a number of components, each of which has a number of major elements of capital investment; in turn, these are intimately and extensively interrelated with other system investments. These systems require massive capital stocks for manufacture; ownership and use; the logistics support system for vehicles; the roadway system; and urban and land use considerations.

A multiplicity of technological factors relating to the manufacture of motor vehicles needs to be recognized, including investments in parts, tooling, and engineering. Lead times involved in bringing about changes in automotive technology are particularly significant. The greater the technological radicalness of the change, the longer the lead time, particularly if the change in technology affects another of the interdependent systems of automotive transport. New technology internal to the vehicle generally involves shorter lead times, but even these may require years.

The auto system requires an enormous logistics support system including hundreds of parts suppliers, tens of thousands of service stations and garages, and the huge capital investment of the petroleum industry in gasoline refining, distribution, and marketing. A change in automotive technology can, of course, imply substantially different skills requirements in the maintenance and service industries. For example, the increased use of electronic devices for control of various functions can introduce severe dislocations into the service industries, with an attendant need for extensive educational and training programs required to provide new skills.

The highway infrastructure is considered a separate component in the automotive transport system because of the enormous capital investment represented by the highway system; the fact that this system is introduced and maintained within the public domain; and the profound effect that its characteristics and existence have on so many other matters relating to automotive transportation. The technology invested in the highway system can be viewed in two different ways. First, it should be examined in terms of the technology involved in laying down the highway surfaces and in erecting the various fixed structures and appurtenances.

Second, highway system technology investment is represented by the set of operating rules and procedures for the use of the highways. These institutional considerations can have a profound effect on the technology of the automotive transportation system, and it is here that their interdependence is so pronounced.

Land use (urban, suburban, rural) is, of course, determined in part by the highway and auto system which provides access, without which most land uses would hardly be possible. Changes in the automobile system will then have a profound impact on land use.

Changes in vehicular technology would also affect raw materials and processing industries. Scrap and recycling industries would probably be the most directly affected.

The paper closes with an appendix, which examines in rigorous theoretical terms the effects of capital stocks on technological changes.

XVII. THE EFFECTS OF EXISTING CAPITAL STOCKS ON TECHNOLOGY ASSESSMENTS

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XVII. THE EFFECTS OF EXISTING CAPITAL STOCKS ON TECHNOLOGY ASSESSMENTS

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An integral component of any complete assessment of technological trends is a sensitivity to the nature of the existing capital stocks. Flows of capital funds are heavily constrained by the stock of capital already in place at the time of an investment decision. Recognition of the capital stock factor will temper judgments of what technological directions are possible in a given time frame.

The basic economic reason that capital stock is an important determinant of technological possibilities is that allocations of investment funds are made from a limited and finite resource pool. Because resources are scarce, priorities must be set among alternative projects of asset acquisitions. These priorities are influenced by those technologies which are feasible. The contention made herein is that future production possibilities are preconditioned by past investment policy. Any credible technology assessment must examine the dislocations in capital stocks that are required to facilitate a projected technological policy.

Service Life

Capital, by definition, is a resource with a significant lifetime. Once a capital stock is formed, it exists for a substantial time until it is scrapped or wears out. The period over which the asset provides a usable output flow is an important dimension of capital stock. This concept, known as "service life," has different connotations for economists, engineers, accountants, technologists, and Internal Revenue Service (IRS) agents. To an economist, service life is the time period over which the product is actually engaged in production. Depreciation is obviously a strong influence over the service life of an asset. It is measured as physical deterioration in terms of incremental units of production. Depreciation and service life can be established on the basis of other factors such as the time period during which the asset can be used in a particular market. Indeed, in the United States, the certificated airlines depreciate airframes over a period which is generally recognized to be significantly less than the actual physical service life of the asset. A third way to calculate service life is via its technological lifetime which may be longer or shorter than its other lifetimes. A fourth way involves accountants who look at past experiences to find precedents; sometimes they consider service life to be the term to maturity of debts used to finance the asset. Finally, IRS constraints or regulatory rulings also influence service life. The definition of service life is, then, an important descriptor of the capital stock in place at any given time. If the establishment of the

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capital's service life is inaccurate and inconsistent, then in all likelihood the timing of investment decisions will be affected.

Sunk Costs

Long-lived capital capable of producing a needed service can be substituted for shorter-lived capital. For example, a Checker cab produces transportation services with a service life several times that of ordinary automobiles. Capital sunk in the Checker cab technology will be producing taxi services a lot longer than capital sunk in shorter-lived taxis.

Compatibility. Sunk costs are also important in shaping future investment policy because any commitment to a particular technology requires compatibility with the existing capital stock. The interface of a new technology with other factors of production must be economically realistic, but it cannot be when the existing infrastructure cannot be integrated with the incremental investment. Compatibility explains why standardization of products is such an important issue in many industries. For example, if couplers on railroad equipment were not standardized, then the introduction of equipment with new couplers would be severely inhibited by incompatibility with the remainder of the fleet.

The compatibility concept has other meanings. Commitments to new technology may require investments in additional support facilities, in interfacing new technology with existing capital stock, or in upgrading existing capital stocks to a higher level of performance matching the new technology. Examples of these secondary technological impacts are widespread in the transportation sector. The introduction of the B-747 jumbo jet necessitated the acquisition of an entirely new (and very expensive) tractor for maneuvering the aircraft to and from the terminal gate. Investments in Metroliner-type rail equipment do not attain their full potential without accompanying investments in upgraded roadbed and raised platforms. Such investment costs should be considered part of technological decision, because the efficiency of the overall system and the new technology can be lowered by the incompatibility of the two capital stocks.

Resale Market. Sunk costs can also be an impediment to flexibility in technological planning; however, investments in long-lived assets do not necessarily preclude replacement of capital, if the resale market is liquid. In fact, there is a highly liquid market for some types of transportation equipment. As a result, operators have the opportunity to reevaluate their current capital stock. Indeed, in the airline industry, the retirement or sale of equipment that is not fully depreciated is virtually a science. Because each manager has calculated an optimal replacement period for his own fleet, aircraft move through several

tiers of use during their physical lifetime. For example, the DC-3 technology is 40 years old, and yet over 500 of them are in service today, many of them in commercial service.

Risk. Another outlook on the sunk costs concept is the risk involved in decisions to shift the technological complexion of a capital stock. Obviously, successful market adaptation of a new technology often comes with high front-end costs needed to research, develop, and market the technological innovation. This commitment must be justified with a prospect for an acceptable return on investment.

Other types of risk are also factors in technological assessments. In the transportation sector, one such risk is the political considerations facing managers of publicly funded enterprises. Technological commitments of the managers of public-sector transportation enterprises can be influenced by legislative bodies. This factor is significant when one considers that legislatures are being asked to fund transportation infrastructure and equipment with expected service lives of 20 to 50 years. The political risks facing managers and the sponsoring legislators in promoting an ill-fated technology is an impediment to pursuit of radical innovations. (Conversely, Congress has funded various agencies with the mandate to develop radical transport innovations.)

In the private sector, the character of the existing capital stock further tempers the direction of new technology because management is reluctant to "write down" assets. Entrepreneurial decisions are constrained by the specter of forced obsolescence of existing assets and the accompanying report of an extraordinary loss.

Demand Influences

One factor with influence on the existing capital stock is demand. Any technological assessment must look toward the demand for the new product or service (and how well that demand is being met by the existing stock of capital). Is this demand sufficient to achieve efficient production levels? In other words, is the gap between present capabilities and future needs big enough to justify investment in the new technology?

Externalities are also an important demand-related factor. Even though the market mechanism is supposed to arbitrate the flow of funds to technologies, it is obvious that the impact of changes in capital stock may have important benefits or detriments for nonusers. One obvious party that could be impacted is labor. Many shifts in investment and technology policies influence adjacent landowners. Capital dislocations are important because idle capacity, changes in land use patterns, or imposition of extraordinary and nonrecoverable economic gains or losses are all externalities likely to arouse vociferous reaction by various parties. Therefore, the imposition of changes in traditional patterns of investment must be tempered by recognition of dislocations among both users and nonusers.

Supply Influences

Changes in capital stock are influenced by supply-side factors. One factor on the supply side is government policy priorities. For example, long-haul intercity rail passenger service is deemed worthy of subsidization even though the service is generally recognized to be economically and technologically obsolete. This policy commitment attached to the supply of public funds definitely influences the trends in technologies needed to serve these markets. In general terms, this case exemplifies a government decision that investments in a specific form of "social overhead capital" are in the public interest.

Foreign trade and international factors sometimes impose constraints on investment flows. Raw material supplies from abroad, balance of payment considerations, tariff restrictions, and foreign policy objectives can direct changes in technology. For example, technologies in electric-powered locomotives would be vastly different in the United States if northern European technologies were unavailable to AMTRAK (which is presently evaluating Swedish locomotive technology). In contrast, federal policy precludes U.S. cities from using Urban Mass Transportation Administration (UMTA) funds for purchase of foreign-made light-rail vehicles. Obviously, if this policy were applied to AMTRAK, the technological direction of rail travel may be quite different.

Another supply-related impediment to utilization of a new technology is an overwhelming commitment to a singular variety of technology. For example, the Association of American Railroads (AAR) and various regulators have resisted innovations in hardware such as braking or coupling because of vast commitments to present techniques. Similarly, in the airline sector, standardized airport planning has conflicted with innovations like mobile passenger lounges which are a substitute for concourse buildings.

Based on the several reasons given above on how past investment policies influence the direction of technological change, the remainder of this paper examines the effects of capital stock on technological changes for different modes of intercity transportation.

AMTRAK

Investment experiences of AMTRAK provide clear examples of how the existing capital stock fundamentally affects technological changes in intercity rail passenger transport; sunk costs in equipment and infrastructure strongly shape the direction of technological activities. A current example is the selection of "scenarios" developed by the Federal Railroad Administration from which development of the Northeast Corridor was planned. The feasibility of each scenario was directly dependent on the existing right-of-way specifications, roadbed conditions, and equipment types. Investment in an extension of the catenary structure from New Haven to Boston is justified, considering the existing

electrified service between Washington and New Haven. Its equipment decisions are also clearly contingent on the fact that future passenger service will be provided on an electrified corridor between Washington and Boston.

AMTRAK investment policy will also be shaped by the compatibility of the acquired assets with the various other components of its system: interchangeability of motive power and passenger fleet, maintenance shop requirements, and required terminal facilities to interface with a new generation of equipment. For example, a decision to operate a train of new equipment design must be formulated with respect to the length of the station platform. Is expensive and disruptive reconstruction required to change platform dimensions? Changes in these or other terminal facilities could have long lasting effects, since their service lives extend up to 50 years.

Future resale of equipment should be an important part of AMTRAK's investment decisions. AMTRAK will have much flexibility in equipment planning, if it can sell used passenger cars to metropolitan commuter operators. If the resale prices approximate the value of comparably depreciated commuter equipment, then the resale value will be several times the scrap value. Thus, the forecasting of resale values 10 or 15 years hence should be a very significant factor in equipment decisions. Similarly, AMTRAK management should be looking closely at opportunities in its terminal facilities. The location of passenger terminals must be considered in light of population distribution and automobile access; a shrewd location decision may generate extensive ancillary revenues ranging from real estate development to that from vendors.

The AMTRAK situation is a good example of the conflicts that can arise between several institutions participating in the provision of intercity rail passenger service. The roadbed is owned by private-sector corporations principally engaged in activities other than moving passengers. AMTRAK, the carrier, is a public-sector enterprise whose funding and goals diverge substantially from those of the suppliers of the rail infrastructure. AMTRAK management is required to provide high quality service to the public at rate levels which entail substantial operating and capital deficits. Furthermore, AMTRAK is encouraged to make long-term investments designed to maximize a long-run social return on public investment. In contrast, the private-sector managers are heavily constrained by the high cost of their capital; they are far more interested in short-term, high-payout investments, typically in equipment, not plant. This dichotomy logically contributes to conflicts in quality of service, pricing, and investment in long-term assets.

AMTRAK also exemplifies ways in which demand factors are important in making future investment decisions. To the extent that demand is influenced by improvements in equipment, then concern over specifications is warranted; some of the variables are speed, reliability, ride characteristics, seating configurations, aesthetics, food and beverage

service, and communications services. These variables are among the factors which must be adjusted to expand AMTRAK's market by attracting new passengers. The impact of changes in these variables must be gauged against demand for transportation alternatives such as automobile, airline, Eastern Air Shuttle, and bus service.

Supply-side factors constrain AMTRAK even more forcefully. One of the most prominent constraints is the threshold size of an order needed for equipment procurement. Recently, new equipment orders have been on the order of several hundred million dollars each. The huge size of each order is due more to the tremendous economies inherent in large-sized orders than AMTRAK's need for large quantities of equipment. AMTRAK is able to achieve significant savings in the price of new equipment if it orders large quantities with standardized features. Thus, the risks in development and tooling of new technologies are spread among a large number of units; savings are also reaped from follow-on orders of a standard design.

Another supply-side factor entering into an investment decision is the operating costs of the new asset. AMTRAK investments have a built-in bias toward labor-saving technologies since capital funds are costless--they are grants. AMTRAK can procure the capital component of its production function for a nominal cost; yet the variable costs of these incremental additions must be recovered through operating revenues. Even though AMTRAK does not depend exclusively upon the "farebox" to pay operating expenses, management realizes that funding for operating deficits is a bigger headache to obtain from Congress than money for hardware. That is to say, AMTRAK's management performance appears better by acquiring a fancy system with no operating deficit than when it expends fewer resources (in the long run) to provide comparable services with a more labor-intensive technique that happens to result in large operating deficits.

Of course, most assets inevitably require some variable inputs. In the AMTRAK case, fuel and crew expenses are difficult to eliminate no matter what technology underlies the equipment. There are opportunities to optimize equipment investments, however. One such opportunity is to forecast and to take into account the levels of maintenance needed for motive power and rolling stock in order to optimize long-run costs, both operating and capital.

Certificated Air Carriers

The certificated air carrier industry is perhaps the best example of a transportation mode that uses innovative equipment as a tool of competition. Because regulation largely prohibits price competition, airlines resort to extensive competition in quality and quantity service. The size and configuration of aircraft are one of the best channels for these competitive efforts. For the certificated air carriers, it is rational to phase out a given aircraft before its physical life has

expired. Indeed, this phenomenon is sufficiently institutionalized so that equipment manufacturers stimulate the reequipping cycles with a steady stream of technological innovations. The development of a new generation of aircraft makes older aircraft obsolete in a particular market.

This phenomenon is relevant to capital stock because these reequipping cycles are made feasible by the liquidity of the used aircraft market. Airlines have succeeded in disposing of aircraft with several years of unamortized investment remaining at prices in excess of book value. (These sales have the added benefit of contributing to accounting profits.) The market in fully depreciated aircraft is liquid because of the myriad commercial and private uses for aircraft no longer needed by the certificated carriers. Thus, this liquidity has enabled the certificated air carriers to engage in frequent modernizations of aircraft technologies.

These changes have not been without disruptions, many of which are traceable to the airline's capital stock in existence at the time of the reequipping cycle. One obvious facet of the capital stock is the route structure of the airline. Because aircraft investments are essentially "lumpy investments"--aircraft are not divisible into fractional units--a plane must be usable within the confines of the carrier's routes. The type of plane is contingent upon passenger counts, peak period loads, stage length, and airport capacity and configuration. As a result, the latest in a given technology is not necessarily relevant to all the certificated carriers. The obvious example is that none of the local service air carriers have purchased a jumbo jet. In fact, several of the local service air carriers at one time operated B-727 aircraft, but they have gradually disposed of even this medium-sized plane. On the other hand, developments in the stretch versions of feeder-route-type aircraft (e.g., DC-9-50) have minimal impact on a technological assessment of trunk carriers.

Compatibility with the capital stock is important to certificated air carriers because a new acquisition must conveniently interface with the carrier's airport-airway system. The productivity of new aircraft, airport facilities, or marketing programs can be severely impaired by unforeseen bottlenecks emerging in the production line. The introduction of the B-747 caused massive disruptions in the normal flows of passengers and baggage until landside systems were adjusted to meet the jumbo-jet technology.

The airport is the classic example of the component in the air travel production function which is overlooked in initial decisions regarding a technological change. These oversights often come back to haunt the carrier and the airport operator. Changing aircraft technology and design have precipitated changes in techniques and design of the interface between the terminal building and the aircraft. The interface has traditionally been a concourse-type building requiring a tremendous capital commitment for the building of a two-story building capable of

providing additional gates for jumbo jets. Expected developments in STOL, QTOL, and cargo aircraft may have future repercussions on the airport area, and especially on concourses.

One of the most interesting developments during the next 50 years will be the emergence of commercial service at satellite airports in the major hub areas. Changing land use patterns and worsened congestion at hubs may increase demand for service to satellite airports. Intermodalism may encourage development of satellites. However, their renaissance is contingent upon technological developments in STOL and QTOL aircraft. Regulatory policies of the Civil Aeronautics Board and the Federal Aviation Administration can also be an inducement to decentralize metropolitan air services. Because the satellite is not likely to have high-density services, airlines will be reluctant to develop the satellite services, unless they can devise ways to operate the small-scale facilities economically.

Because of the increasing costs of raising funds for construction of new airports, it is expected that the "ground up" airport exemplified by the Dallas-Ft. Worth Regional Airport is highly unlikely to be chosen in the future as the solution to landside problems. Most planners are constrained to seek ways to prolong the lifetime of the existing capital stocks of land, access facilities, runways, terminal buildings, and parking facilities. As a result, technological activities aimed at alleviating peak period congestion and cramped facilities may be all the more crucial.

Capital stock influences technological assessments in this industry in still another way--cross-subsidization by equipment manufacturers. Since World War II, much technology used in passenger air transport was originally developed on behalf of the Department of Defense. In effect, much of the risk bearing needed to develop innovations in airframes, power plants, and avionics has come about, at least in part, as as result of military expenditures. The private-sector has been able to apply these technologies to commercial use. This spillover impact has been important in the past, and its continuation will assist the certificated air carriers in obtaining innovations--both good and bad--for their use.

To this point, the discussion of certificated air carriers has concentrated on the influences of existing technologies upon new technologies. Technological changes are shaped by the demand for air service which has cross elasticities in various markets with demand for short-haul high-speed rail, automobiles, some exotic modes (e.g., TACV), buses, and several nontransport substitutes for travel (telecommunications, computers, and relocation decisions). In addition, demand factors within the air travel industry affect the directions of technological changes. The best example is the heroic--but so far unsuccessful--struggles of the Concorde to obtain a niche in the fleets of the major air carriers of the world. The Concorde has been heavily constrained by the airlines' perception that capital and operating costs are too high for the

demand for supersonic air travel. In light of its substitutes (conventional subsonic jets), the Concorde technology does not now generate a differential demand (for supersonic as opposed to subsonic travel) sufficient to make an investment profitable.

Similarly, other marketing and technological innovations of the air carriers must also be looked at in light of the demand for the service they provide. Another example is Laker Airways' proposed "Skybus" service from New York to London. (Similar concepts have been proposed for U.S. routes.) The Skybus is a radical departure in the marketing of jumbo-jet technologies. Regulation has impeded market testing of this innovation. However, if the Skybus is introduced, its success will depend on new demand for this type of service over and above conventional air service.

Introduction of new technologies into the certificated air carrier field is tempered by the realities on the supply side of air service. A prominent supply-side constraint is the scarcity of capital funds to finance new reequipping cycles. Simply put, the balance sheet prevents expansion into more than one major reequipment project. These financial constraints are definitely related to the existing capital stock which is the strength and security of the balance sheet. These financial limitations force the airlines to select only a few of the available additions to their stock of assets. As an example, a massive reequipment cycle to medium-size jets (e.g., 727-300) probably could not be financed if a supersonic aircraft were added to the fleet during the same time.

The compatibility theme carries over to the supply side because a major component in the operating expenses of an airline is the maintenance program. Normally, increased homogeneity of a fleet enables cheaper maintenance through savings in inventories, skills of maintenance personnel, and interchangeability of spares. Thus, an important cost consideration relates to the compatibility of existing equipment with new technologies. The diverse array of available engines which can be installed in the basic DC-10 airframe has resulted from the purchaser's desire to standardize the DC-10 engines with the power plants on their other aircraft. Because several of the airlines purchasing DC-10s preferred a Pratt & Whitney power plant to the standard General Electric power plant, McDonnell Douglas produced a DC-10 with Pratt & Whitney engines compatible with the B-747s of the purchaser.

In summary, this discussion of the certificated air carriers shows that the existing capital stocks of the carriers and the airport operators play a fundamental role in the speed and direction of technological change. In this particular case, the most important phenomenon is the compatibilities of the existing route structure, aircraft fleet, and terminal facilities with the projected acquisitions.

Automotive Transportation

As with AMTRAK and the airlines, automotive transport evidences influences of past capital investment on technological change. The automotive transportation system, including trucks, buses, and other highway motor vehicles of all transportation modes, exhibits the highest degree of inertia, technological and otherwise. This inertia is related to past capital investment decisions. It is important to recognize not only that the automotive transportation system consists of a number of components, each of which has a number of major elements of capital investment, but also that these system components, in turn, are intimately interrelated with other systems investments. This interaction among the components evolved over a considerable period of time with a net result of an extremely high degree of interdependency with major impacts on technology and the behavior patterns of institutions which built around this technology. In order to illustrate at least part of this complexity and interdependency, there are a number of issues to be noted concerning vehicles: their manufacture, ownership, and use; the logistics support system for these vehicles; the roadway system; urban and land use considerations; plus a variety of additional subject matters.

Vehicles. There are two broad categories of issues concerning vehicles. On the one hand, there are those factors relating to the users' investment in an inventory of vehicles, which at the present time, consists of something on the order of 100 million private passenger cars, about 25 million trucks, and approximately 500,000 buses. In addition, there is the consideration of the users' learning behavior concerning the operation of motor vehicles, and the many elements concerning cultural patterns which are intimately bound up with the private passenger car. On the other hand, there is a multiplicity of technological factors relating to the manufacture of motor vehicles which need to be recognized, including investment in plant, tooling, and engineering. Of particular concern is the matter of the lead times involved in bringing about changes in automotive technology. In general, the greater the magnitude of the change, the longer the lead time. This is particularly true if the change in technology affects one or another of the elements interdependent with the automobile. New technology internal to the vehicle generally involves shorter lead times, but even these still may require years. For example, the development of an automotive gas turbine from the prototype stage to mass production has been estimated to require approximately 11 years, with 16 years required to move into full production. While the example of a gas turbine may be considered internal to the vehicle, there are, of course, many external ramifications of such a change, including a substantial impact on parts suppliers, service and maintenance industries, fuel production and distribution industries, to mention only the most obvious.

Logistics Support Systems. As suggested above, the passenger car and motor vehicle transportation system entails an enormous logistics

support system including hundreds of parts suppliers, tens of thousands of service stations and garages, and the major capital investment of the petroleum industry in gasoline refining, distribution, and marketing. It is appropriate to note in this latter regard that changes in automotive engine technology--whether mandated by federal regulation or the result of evolutionary engineering development--can have profound implications on refinery product requirements and the demand for gasoline of various octane numbers and antiknock compounds. The circumstance, for example, that new engines may require lead-free gasoline of a certain research octane number must be taken in relation to the circumstance that there is a changing inventory--or capital stock--of older cars with varying requirements for gasoline. Similarly, the development of catalytic converters for exhaust emissions control, which includes the use of platinum and paladium, imposes severe demands on the minerals production and refining industries and the related technology of catalyst development. A change in automotive technology can imply substantially different skill requirements in the maintenance and service industries. For example, the increased use of electronic devices for control of various functions can introduce severe dislocations into the service industries with an attendant need for extensive educational and training programs required to provide new skills.

The Highway System. While the highway system might be regarded as part of the logistic support system, it is appropriate to consider it separately in view of (1) the enormous capital investment represented by the highway system, (2) the fact that this system is introduced and maintained within the public domain, and (3) the profound effect that its characteristics and existence have on so many other matters related to automotive transportation. The technology invested in the highway system can be viewed in two different ways.

First, it should be examined in terms of the technology involved in laying down of highway surfaces and erecting the various fixed structures and appurtenances thereto. Involved, of course, is an enormous investment in structures and roadways. (Issues relating to the use of rights-of-ways and the land removed from other uses by being dedicated to highway use will be discussed below.)

The second point of view concerning highway technology is that represented by the set of operating rules and procedures for the use of the highways. These institutional considerations can have a profound effect on the technology of the automotive transportation system, and it is here that their interdependence is so pronounced. It is appropriate to note that what might appear to be relatively small changes in operating rules can have very large implications for the rest of the system. What might appear to be change with few technological impacts, for example, is the reduction of maximum speed limits to 55 miles per hour for all vehicles on all roadways. The basis for the development of a motor freight transportation system was a speed limit over 55 miles an hour and the longer stage length permitted by higher speed. As a result, major terminals

and distribution points and labor work rules are such that a trucker cannot complete the haul between major terminal points in the time permitted by the Teamsters work rules and still abide by the federal safety regulations traveling at 55 miles per hour. In the long run, more dramatic changes can emerge from regulatory changes in the maximum load limits of double- and single-bottom trailers.

Urban and Other Land Use Consideration. It is important to recognize that patterns of land use in the United States (urban, suburban, rural) are determined to a major degree by the highway system and automotive transportation. While it is undeniable that a large quantity of real estate is dedicated to highway and roadway use, it is equally important to recognize that most other land uses are influenced by the highway system--it provides access without which most other land uses would hardly be possible. Residential areas, regional shopping centers, and industry are typically accessible only by automotive transportation. Therefore, any significant change that might be contemplated concerning the use and characteristics of automobiles may have a profound impact on all of these dependent land uses. Stated another way, the incredibly vast capital investment in land use that is dependent in one way or another on automotive transportation, and the access provided by such transportation, represents an enormous initial component to technology change that might conflict with such investment.

Other Automotive-Dependent Industries and Concerns. While a number of raw materials and processing industries would be affected by changes in automotive technology, probably the most directly affected would be the scrap and recycling industries. Changes in material inputs to the manufacture of automobiles will appear as inputs to the scrap processing industry when the automobile reaches the end of its useful life. As the stock of cars-in-use changes over time, there may be substantial changes in the inputs to the scrap processing industries. Capital investment in scrap processing technologies can, of course, have an impact on determining that part of the materials stream that is reprocessed.

The net import of the preceding observations is that change in the technology of automotive transportation can only be incremental and probably can occur realistically only in relatively small steps. The larger the attempted change regarding the technology at hand, the more difficult the transition will be; efforts to accelerate the transition are likely to result in excessive costs and inefficiencies. While the vehicle is probably the most important from the point of view of technology, it is nevertheless also the case that large change in the use or ownership of automobiles is likely to be accompanied by substantial changes in the entire bundle of considerations that make up urban land use and American culture.

Appendix

ANALYSIS OF TRANSPORT INVESTMENT FLOWS

The concepts of stock and flow are often confused in investment theory. The stock concept refers to a value which has no time dimension (although, of course, it exists in time). It is an absolute number such as dollars. Time is used only to denote various dates on which the stock is (was) held. Flows, on the other hand, have a time dimension; e.g., a flow per unit of time, dollars per unit of time. Furthermore, investment is a flow item, while capital is a stock item. Capital is augmented by investment; capital stock shrinks through depreciation and disinvestment.

Given pieces of capital equipment will be replaced from time to time under certain prescribed conditions (to be outlined below). The optimal replacement pattern of capital stock through a flow of new investments is relevant for new technology projections and for the acceptance of those projections.

Investments (flows) cannot be projected unless some inventory of the existing capital (stock) is taken at the time of projection. For an individual who must merely replace existing machines with like machines, a machine is replaced when its marginal rate of quasi-rent flow per year net of depreciation equals the present value of the average return per year of a new machine net of its investment cost, less the scrap value of the old machine. The same basic rules follow for the replacement of an existing piece of capital by a new type of capital with a different revenue expectation, cost, and scrap value.

The general theory of optimal capital replacement follows the treatment of Henderson and Quandt (*Microeconomic Theory*, McGraw Hill, New York, 1971, pp. 325-329).

Suppose that a piece of capital equipment produces an output Q which sells for P. For simplicity, assume that P is independent of the number of Q produced, i.e., the demand curve is horizontal as perceived by the producer. The amount of revenue generated during time period t is q_t (a flow concept). The amount of revenue generated during time period t is thus Pq_t.

The cost of the piece of capital equipment at time zero is I_o. The input cost flow is C_t at time t, and it is a function of the amount of $Q(q_t)$ produced. The capital must be maintained, and maintenance costs M_t are a function of output flow and age.

We would expect

$$\frac{\partial C_t}{\partial q_t} > 0$$

That is, input costs increase as more output is produced (unless there are scale economies in the production of the product).

$$\frac{\partial M_t}{\partial q_t} > 0$$

That is, the more output (use) produced by a unit of capital, in any given time period, the more maintenance is necessary to keep the equipment in working order.

$$\frac{\partial M_t}{\partial t} > 0$$

That is, as the equipment gets older, the maintenance costs required to produce a unit of output increase.

The piece of equipment can be sold for scrap when it is decided that its productive days are over. The scrap value of the machine at time t is $S_t(t)$ and is a decreasing function of its age; that is, $\frac{\partial S_t}{\partial t} < 0$. $\frac{\partial S_t}{\partial t}$ gives the rate of loss of market value from continuing to use the machine--depreciation. Of course, one could also assume that a buyer who wished to use the equipment might exist and that the equipment would be sold to the buyer or for scrap, whichever is higher. In transportation, much equipment tends to pass on from owner to owner before it is scrapped; e.g., an extensive market for used automobiles exists in the U.S.; old AMTRAK coaches may find their way into local commuter operations, and aircraft will filter from trunks to local service carriers and ultimately out of the country. What is discarded by one becomes new and superior for another. Producers of capital, through obsolescence and market competitive factors, may cause certain pieces of capital equipment to be sold (scrapped) long before the physical life of the capital has been exhausted. The aircraft industry is one such example.

The quasi-rent flow (i.e., profit) to the owner of the capital which is producing q_t at time t is

$$Z_t = Pq_t - C(q_t) - M(q_t,t)$$

The present value (required because the operations and sales of the capital equipment occur over time) of the profit from the operation of the capital equipment is the present value of the quasi-rent stream minus the cost of the machine, plus the present value of the scrap receipts:

$$\pi_1 = \int_0^T Z(t)e^{-it}\,dt - I_o + S(T)e^{-it}$$

where

e^{-it} is the time continuous discount factor.

The initial problem is to find the optimal time T for an analysis where just one machine will be bought. The owner of the equipment wants to know when is the optimal time to stop using the machine. This is found as

$$\frac{d\pi_1}{dT} = [Z(T) - iS(T) + S'(T)]e^{-iT} = 0$$

so that

$$Z(T) + S'(T) = iS(T)$$

Thus, the equipment will be retired when quasi-rent less depreciation (recall $S'(T) < 0$) equals the interest received from investment of the scrap value.

However, if this firm is to produce forever, its problem is not when to retire the initial capital equipment, but when to replace it with new equipment and, further, when to replace that equipment with new equipment ad infinitum.

C. 5

Assume that $Z(t)$, I_o, and $S(t)$ are the same for each piece of capital equipment (except for dates). Also assume that the planned lives of the equipment are identical. Thus, the present value of the equipment is:

First equipment
$$\pi_1 = \int_o^T Z(t)e^{-it}dt - I_o + S(T)e^{-iT}$$

Second (replacement) equipment
$$\pi_2 = \int_T^{2T} Z(t - T)e^{-it}dt - I_o e^{-iT} + S(T)e^{-i2T} = \pi_1 e^{-iT}$$

Third equipment
$$\pi_3 = \int_{2T}^{3T} Z(t - 2T)e^{-it}dt - I_o e^{-i2T} + S(T)e^{-i3T} = \pi_1 e^{-i2T}$$

.
.
.

nth equipment
$$\pi_n = \int_{(n-1)T}^{nT} Z(t - nT)e^{-it}dt - I_o e^{-i(n-1)T} + S(T)e^{-inT}$$

$$= \pi_1 e^{-i(n-1)T}$$

thus, in general,

$$\pi_h = [\int_o^T Z(t)e^{-it}dt - I_o + S(T)e^{-iT}]e^{-i(h - 1)T}$$

The present value of the aggregate profit from an infinite stream of machines is

$$\pi = \sum_{h=1}^{\infty} \pi_h = \frac{\int_o^T Z(t)e^{-it}dt - I_o + S(T)e^{-iT}}{1 - e^{-iT}} = \frac{\pi_1}{1 - e^{-iT}}$$

where

$(1 - e^{-it})^{-1}$ is the sum to infinity of the geometric progression

$[1 + e^{-iT} + e^{-i2T} + e^{-i3T} + \ldots]$

The optimal T is found from $\frac{d\pi}{DT} = 0$, that is,

$$\frac{d}{DT} = \frac{(1 - e^{-iT})\left[Z(T) - iS(T) + S'(T)\right]e^{-iT} - ie^{-iT}\left[\int_o^T Z(t)e^{-it}dt - I_o + S(T)e^{-iT}\right]}{(1 - e^{-iT})^2}$$

which will equal zero if

$$(1 - e^{-iT})[Z(T) - iS(T) + S'(T)]e^{-iT} = ie^{-it}\left[\int_o^T Z(t)e^{-it}dt - I_o + S(T)e^{-iT}\right]$$

Since e^{-iT} is on both sides of the equality, the equality will hold if

$$(1 - e^{-iT})[Z(T) - iS(T) + S'(T)] = i\left[\int_o^T Z(t)e^{-it}dt - I_o + S(T)e^{-iT}\right]$$

or

$$(1 - e^{-iT})[Z(T) + S'(T)] - iS(T) + iS(T)e^{-iT} = i\left[\int_o^T Z(t)e^{-it}dt - I_o\right] + iS(T)e^{-iT}$$

subtracting $iS(T)e^{-iT}$ and adding $iS(T)$ to both sides yields

$$(1 - e^{-iT})[Z(T) + S'(T)] = i\left[\int_o^T Z(t)e^{-it}dt - I_o + S(T)\right]$$

or

$$Z(T) + S'(T) = \frac{i}{1 - e^{-iT}} \left[\int_o^T Z(t)e^{-it}dt - I_o + S(T) \right]$$

or

$$Z(T) + S'(t) = \frac{1}{\delta} \left[\int_o^T Z(t)e^{-it}dt - I_o + S(T) \right]$$

where

$$\delta = \frac{1 - e^{-iT}}{i} = \int_o^T e^{-it}dt,$$

that is, the present value of a one dollar income stream for T years.

Thus, as stated above, capital equipment is replaced when its marginal rate of quasi-rent flow per year less depreciation, i.e., $Z(T) + S'(T)$, equals the present value of the average return per year of a new piece of equipment, net of its investment cost less the scrap value of the old machine. $\left[\int_o^T Z(t)e^{-it}dt - I_o + S(T) \right]$ gives a return for T years, and thus, the multiplication by $\frac{1}{\delta}$ annualizes the return.

Note that the solution for the one piece of equipment problem, i.e., $Z(T) + S'(T) = iS(T)$, differs quite a bit from the solution of the replacement of capital problem, that is,

$$Z(T) + S'(T) = \frac{1}{\delta} \left[\int_o^T Z(t)e^{-it}dt - I_o \right] + \frac{is(T)}{1 - e^{-iT}}$$

The difference, of course, reflects the difference in the options open to the decision maker, since the decision maker replacing capital will operate new machines.

At any given point of time, a firm will have a given capital stock. Whether they will sell or scrap that capital stock and invest (flow) in a different piece of equipment depends on the expected Z(t) function of the new capital equipment vis-a-vis the capital equipment on hand, the purchase cost of a new piece of capital, the scrap or sale value of the old and the new equipment, and of course the discount rate i. The equation

$$Z(T) + S'(T) = \frac{1}{\delta}\left[\int_o^T Z(t)e^{-it}dt - I_o + S(T)\right]$$

can be rewritten

$$\delta[Z(T) + S'(T)] = \int_o^T Z(t)e^{-it}dt - I_o + S(T)$$

or

$$I_o - S(T) = \int_o^T Z(t)e^{-it}dt - \delta[Z(T) + S'(T)]$$

Since $\delta = \int_o^T e^{-it}dt$, the second part of the right-hand side of the above equation becomes

$$\int_o^T [Z(T) + S'(T)]e^{-it}dt$$

thus the equation becomes

$$I_o - S(T) = \int_o^T \{Z(t) - [Z(T) + S'(T)]\}e^{-it}dt \qquad (A)$$

also note that

$$iS(T)\int_o^T e^{-it}dt = iS(T)\left[\frac{1 - e^{-iT}}{i}\right] = S(T) - S(T)e^{-iT}$$

Thus, if $iS(T)\int_o^T e^{-it}dt$ is added to both sides of the above question [call it Equation (A)], then we obtain

$$I_o - S(T)e^{-iT} = \int_o^T \{Z(t) - [Z(T) + S'(T) - iS(T)]\}e^{-it}dt \qquad (B)$$

Equation (B) is another traditional way of expressing the optimal replacement problem.

Calling

$C(T) = I_o - S(T)e^{-iT}$ = The capital consumption of the investment.

$G(T) = Z(T) + \frac{dS(T)}{dT} - iS(T)$ = The generated surplus of the investment, that is, the net operating receipts at time T[Z(T)] plus the loss of salvage value $\left[\frac{dS(T)}{dT}\right]$ minus the opportunity cost of the salvage value [iS(T)].

G(T) is thus the revenue from keeping the investment for an additional short time period. Substituting above in (B) yields

$$\int_o^T \{Z(t) - G(T)\}e^{-it}dt = C(T) \qquad (C)$$

where

$Z(T) - G(T)$ = inferiority in revenue between the investment now in use and an investment which is T years old.

Thus, (C) says that when the sum of the present value of the revenue inferiority is equal to the capital consumption of the investment, it is time to reinvest. If $\frac{dS}{dT} \simeq 0$, then equation (B) becomes

$$\int_0^T \{Z(t) - Z(T) + iS(T)\}e^{-it}dt = I_o - S(T)e^{-iT} \qquad (D)$$

or

$$\int_0^T \{Z(t) - Z(T)\}e^{-it}dt + iS(T)\int_0^T e^{-it}dt = I_o - S(T)e^{-iT} \qquad (E)$$

or

$$\int_0^T \{Z(t) - Z(T)\}e^{-it}dt + iS(T)\left\{\frac{1 - e^{-iT}}{i}\right\} = I_o - S(T)e^{-iT} \qquad (F)$$

or

$$\int_0^T \{Z(t) - Z(T)\}e^{-it}dt + S(T) - S(T)e^{-iT} = I_o - S(T)e^{-iT} \qquad (G)$$

or

$$\int_0^T \{Z(t) - Z(T)\}e^{-it}dt = I_o - S(T). \qquad (H)$$

Consider the sensitivity of the above model to changes in investment costs, the discount rate, net operating receipts, and salvage value. Equation (H) is used for simplicity, i.e., we assume $\frac{dS}{dT} \simeq 0$. (The

results don't change in spirit as the result of this assumption, but the mathematics is much simpler.)

Suppose investment costs change. How is the optimal service life affected? If equation (H) is differentiated with respect to I_o, the result is

$$\int_o^T - \frac{dZ(T)}{dT} e^{-it} dt \frac{dT}{dI_o} = 1 - \frac{dS(T)}{dT} \qquad (I)$$

or

$$\int_o^T - \frac{dZ(T)}{dT} e^{-it} dt \frac{dT}{dI_o} = 1, \text{ since } \frac{dS(T)}{dT} = 0 \qquad (J)$$

Since $\frac{dZ(T)}{dT} < 0$, for the left hand side of (J) to be positive, then $\frac{dT}{dI_o} > 0$, that is, the larger the investment costs, I_o, the longer the service life, T.

Suppose the discount rate changes. If equation (H) is differentiated with respect to i, the result is

$$\int_o^{T(i)} - \frac{dZ}{dT} e^{-it} dt \frac{dT}{di} + \int_o^{T(i)} - tZ(t)e^{-it} dt = 0 \qquad (K)$$

Since the right-hand most term of (K) is negative, the left-hand term must be positive so that (K) may equal zero. Since $\frac{dZ}{dT} < 0$, then $\frac{dT}{di} > 0$, that is, the service life, T, increases as the discount rate increases. This increase in i expresses a scarcity of money and thus a willingness to postpone investment. The present value of the new investment decreases; thus the attractiveness of the alternative

decreases, and the existing investment is retained for a longer period of time.

Suppose that the net operating receipts change. If Equation (H) is differentiated with respect to Z, the result is,

$$\int_0^T -\frac{dZ}{dT} e^{-it} dt \frac{dT}{dZ} + \int_0^T \frac{d[Z(t) - Z(T)]}{dZ} e^{-it} dt = 0 \qquad (L)$$

Since the second term on the left-hand side equals zero, so does the first term. Thus $\frac{dT}{dZ} = 0$, that is, if the change in net operating receipts is independent of time (a parallel and straight-line shift upward or downward over time), the optimal service life will not be affected.

However, if net operating revenues have a deterioration which is a function of time (a nonparallel shift) and this deterioration is denoted by a, it can be shown that $\frac{d[Z(t) - Z(T)]}{da} > 0$ and so $\frac{dT}{da} < 0$, that is, the optimal service life will decrease when the deterioration increases.

Suppose the salvage value changes. If Equation (H) is differentiated with respect to S, the result is,

$$\int_0^T -\frac{dZ}{dT} e^{-it} dt \frac{dT}{dS} = -1 \qquad (M)$$

Since $\frac{dZ}{dT} < 0$, Equation (M) implies that $\frac{dT}{dS} < 0$, that is, increasing salvage value decreases the optimal service life.

The above analysis somewhat hid the effects of maintenance costs in Z(t) and Z(T). If such costs are separated from Z and made explicit,

a fuller appreciation of the interdependence of maintenance on net operating receipts and on salvage value can be shown. In general, increased levels of maintenance will improve salvage value and improve net operating receipts (receipts exclusive of maintenance). The analogue of Equation (B) becomes

$$\int_0^T \left\{Z_o(t) + X(t) - Z_o(T) + X(T) + L(V(T),T) - iS(T)\right\} e^{-it} dt$$

$$= I - e^{-iT} S(T) + \int_0^T V(t) e^{-it} dt \qquad (N)$$

where

$X(T)$ = the accumlated effect on net operating receipts of previous outlays for maintenance expenditures

$L(V(t),t) = \frac{dS}{dt}$ = the change in salvage value with time which is a function of the maintenance done on the investments and the age of the investment

$V(t)$ = maintenance expenditures at time t.

Since a prediction of the flow cannot be made without knowledge of a firm's existing stock, the demand for the service, and the likely behavior of competitors, among other items, it will be difficult to predict what the investment flows of the future will be and indeed what the capital stock of the future will be (since capital stock of time period t will equal the capital stock of time period t-1 plus the *net* investment from time t-1 to time t) without knowledge of these items. This is no small task since predicting future demands is a major project in its own right.

XVIII. THE AUTO-INDUSTRIAL ERA--IS IT AT AN END?

by

John Mollenkopf
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ABSTRACT

Massive road networks and relatively low front-end costs have made the car a flexible, convenient and popular way to travel. The car not only symbolized America's post-World War II affluence, it was one of the main devices by which that affluence was achieved. World politics and domestic cleavages have, however, tarnished this symbol. Though the enormity of our society's investment prescribes continued auto usage, future decisions about incremental changes in the auto system will definitely be made by criteria far different than those common place over the past few decades.

This paper explores the automobile-based mobility system and the forces which may alter, and perhaps diminish, its role in intercity travel.

A breakdown is occurring within the auto-industrial complex, accentuated by changes in political views, social values, and life patterns among car users and policy makers. Related impacts include, for example, rising energy prices, the no-growth movement, labor antagonisms on the assembly line, industry market saturation and technological exhaustion, negative externality and social costs, and a shift in federal investments from freeway to bus and mass transit systems.

Perception of such impacts must necessarily be impressionistic, but the net effect will be to reduce auto usage, encourage use of small autos, make bus technologies more attractive, and increase air travel over longer distances.

Technologies which have high new capital requirements or which would require the abandonment of existing public capital are highly unlikely to replace the automobile as the main source of intercity mobility. Bus technology, and to a lesser extent, airplane technology, will be the main beneficiaries of a decrease in automobile usage.

New technology investments would appear to have, for example, the following general characteristics : no major demands for social capita; a changed pattern of highway capital investment; reduced energy and per capita costs; lower social, pollution, and congestion costs; and concentration of metropolitan development.

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XVIII. THE AUTO-INDUSTRIAL ERA--IS IT AT AN END?

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Summary

The usual method for predicting demand for intercity travel involves the regression of travel behavior against disposable income, the costs of various modes in time and money, population and economic activity trends, the velocity of money, and similar factors. This method can yield highly accurate projections when these independent variables remain insulated from the tidal pressures exerted by basic social changes. When and if the tide does change, however, the typical regression equations become treacherously unreliable--one need only think, for example, of the impact of rising oil prices on U.S. automobile sales. Any careful consideration of the future of intercity travel demands must therefore scout out forces which, even though their present impact is relatively marginal, portend major shifts in what now seem to be stable explanatory patterns.

This paper explores the automobile-based mobility system and the forces which may alter, and perhaps diminish, its role. It will consider not only how viable the automobile-based transportation system will be, but also how lessons from the automobile case can be applied to alternative technologies in order to evaluate their likelihood and workability.

The basic thesis with which we must grapple is that major social forces have been undermining the economic, political, and social foundations which support the automobile-oriented society. These forces range from rising energy prices and the no-growth movement to labor antagonisms on the assembly line. While they may not lead to the abandonment of the auto, these forces will lead our society to revise the auto's role and to supplant partially the existing technology. Newer technologies, however, will face the same general forces now bearing down on the automobile-industrial complex. As a result, technologies which have high new capital requirements or would require the abandonment of existing public capital are highly unlikely to replace the automobile as the main source of intercity mobility. In the final analysis, it is the author's view that bus technology, and to a lesser extent airplane technology, will, quite fittingly, be the main beneficiaries of these trends. High-technology solutions like space shuttle and intercity rail rapid transit will, it is felt, be ruled out by the same forces which will encourage bus technology.

The forces acting on the auto-industrial complex may be summarized under two main headings: forces of breakdown within the auto-industrial complex itself and changes in values, social life patterns, and political views among car users and policy makers.

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1. Forces of breakdown within the automobile-industrial complex

   a. Market saturation and technological exhaustion within the automobile industry.

   b. The accumulation of negative externalities and social costs generated by the automobile.

   c. The advent of a general era of austerity within the U.S. with an expressed desire by the business community and federal economic policy-makers to shift resources from consumption to investment.

   d. The shift in control of world oil resources to the OPEC nations with the consequent rise in oil prices, both absolutely and relatively.

   e. Rising antagonism on the production line which, though a general phenomenon in U.S. industry, is especially concentrated in automobile production.

   f. A shift in federal investments away from increased private intercity transit facilities (freeways) toward urban and public facilities (bus systems).

2. The end of the love affair with the car

   a. Rising political opposition to freeway construction; the development of no-growth political coalitions in metropolitan areas.

   b. Development of a consensus within policy-oriented elites in favor of reorienting transportation policy toward urban mass transit.

   c. A slowing of suburbanization, the formation of suburban families, and birth rates, with a reinvigoration of urban social life, with consequently less emphasis on car ownership.

   d. Changing values among the young in terms of interest in smaller cars and non-car transportation.

Each of these developments can even now be regarded as having substantial impacts on the role of the auto, though at present the perception of such impacts must necessarily be impressionistic. Their net effect will be to reduce the importance of the auto, encourage the replacement of large autos by small ones, make bus technologies more attractive, and also make air travel more attractive over longer distances.

The institutional interests pushing to maintain an automobile-based mobility system have historically been strong and, though they are increasingly divided, will remain strong in the future. Regardless of the merits of the issue, a substantial policy orientation toward car-like technologies will therefore probably continue. But on the merits as well, it appears that new technology investments, if they are to be viable and helpful, will have the following general characteristics.

1. They will not impose major new demands for social capital nor substantially increase governmental outlays for "unproductive" activities.

2. They will not abandon highway capital investments, but probably make somewhat different uses of them.

3. They will conserve on energy and per capita costs.

4. They will involve lower social, pollution, and congestion costs.

5. They will tend to concentrate, rather than further disperse, metropolitan development.

6. Since a reduction in consumption expenditures will be paramount, they will tend to be collectively organized, and therefore publicly financed, rather than privately owned.

7. They will be shaped especially to serve politically important groups whose mobility has been impaired in the past by the auto-organized system (namely the elderly, disabled, and working poor), or whose mobility will be impaired by increasing expenses of mobility (namely white collar metropolitan commuters).

These constraints on future technology development stem directly from the forces outlined above. If these forces are actually operating at significant levels, and if the resulting constraints do come into play, then many of the technologies being proposed for intercity transit are at best naive and at worst extremely wasteful approaches. Instead, the author recommends a mundane but ultimately most useful alternative: bus technology. While smaller cars, perhaps electrically powered, might satisfy many of the conditions set out above, they cannot hope to have the short-term impact which high-speed, high-quality bus service could provide. In addition, some improvement of existing airline technology would help provide an alternative to longer range intercity car travel.

This line of reasoning is reinforced if one considers how the forces described above will affect intracity travel. They will obviously reduce the attractiveness of the individual auto, especially the larger ones. To the extent that urban transportation policy

additionally concentrates development and renders car ownership less necessary, such intercity options as buses, rental cars, airplanes, and even rail will become more attractive. Of these possibilities, of course, buses best meet the criteria set out. In the final analysis, this author contends then, that investments in bus technology prove to be the superior choice.

The highway complex forms one of the two principal elements of intercity travel behavior. The prevalence of cars, the massive road network, and the relatively low front-end costs to individual participation to this form of travel have made the car a flexible, convenient, and popular way to travel. Indeed, in the past 30 years, it has dominated the choices available to the average American. But this highly structured range of choices is not the only important determinant of intercity travel behavior.

The other element is a mobility-oriented life-style in which the car is a central comsumption item for the individual family. Not only was highway-based travel the main choice open to travelers, the car has attained, it seems, a central commercial, psychological, and avocational role in American life. More than any other good, it represents the affluence of consumption in our society. Working class kids tirelessly install mag wheels and headers and cruise through the drive-ins, while their more middle class peers still join the search for the perfect place to "park." To their parents a new car is as important a status symbol as a suburban tract house, while mammoth camper vans now constitute the ultimate American marriage between town and country. This car-oriented life style not only represents our society's edge over less affluent countries, it performs a critical, dual economic function of encouraging consumption and providing for economic growth.

In short, the car not only symbolized America's post-World War II affluence, it was one of the main devices by which that affluence was achieved. It appears, however, that world politics and domestic cleavages have combined decisively to do in this epoch. The enormity of our society's investment in automobile-oriented ways will necessarily give them considerable momentum into the future, but decisions about incremental changes will definitely be made by criteria far different from those commonplace over the past few decades.

Extended Discussion

Background. Since the 1920s, and especially since the post-World War II freeway and suburb-building boom, America has become a society whose mobility has increasingly centered on the automobile. At the national level, a political alliance of automobile manufacturers, oil companies, road building contractors, highway users, and real estate developers backed federal transportation policies which invested over $80 billion in freeways and caused federal, state, and local

governments to spend more than $260 billion on highways.* At the local level, new freeways, increased automobile sales, and rapid suburbanization provided a powerful impetus to the post-World War II economy. Indeed, some would argue that without this rapid growth of land values and home building another depression would have followed the war. Metropolitan highway construction and the growth of car ownership proved to be the *sine qua non* for the post-war suburban boom. The growth of suburbs, car ownership, and commuting was more than compatible with using cars for longer-distance travel. By the mid-1960s, America was a full-blown highway society with car-related expenditures making up the single biggest item in the GNP.

It is not surprising that, as a consequence, when one speaks of intercity travel, one speaks of the auto. According to statistics published by the Transportation Association of America, seven out of eight person-trips longer than 100 miles are made by automobile. Naturally, air travel cuts into auto usage for the longer trips, but even on trips of over 1,000 miles, cars carry 63% of the travelers.**

While the evidence is not all in, the U.S. appears to have lost its undisputed position in the nonsocialist world. The heavy costs of a failing war, increased competition from Western Europe and Japan, relatively low rates of domestic productivity increase, and the costs of maintaining domestic peace during the 1960s have combined to undermine U.S. predominance, and therefore, U.S. affluence. These trends are all represented strongly in the auto industry, where foreign small cars manufactured in highly productive plants have eroded the Big Three's hold on the U.S. market. (Figures gathered by the California Department of Transportation show that in the first quarter of 1975 almost 70% of all new car registrations in California were foreign makes!) Additionally, national policies designed to deflate the economy will necessarily reduce the common citizen's ability to buy and use cars, and to maintain the kind of lifestyle which requires large amounts of auto travel to continue.

This downturn would not be so troublesome if it were only a short-range economic difficulty. But since it stems from the U.S.'s declining international position, it poses a chronic problem. It means, in short, that America can no longer so freely afford the car; the economy cannot afford the car's technological stagnation, its social costs, the lavishness with which consumers spend money on it, the way it devours gas and oil, the expense of dealing with increasingly

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*Figures come from Transportation Association of America, *Transportation Facts and Trends*, Tenth Edition, October 1973, p. 26. For discussions of the highway lobby and the origins of federal highway policy, Helen Leavitt, *Superhighway-Superhoax* (New York, Doubleday, 1970).

**ATA, *Transportation Facts and Trends*, p. 20.

antagonistic production workers, nor the expense of subsidizing its use through the highway program. (Highway maintenance costs represent a time bomb for government budgets. California Highway Department projections show the maintenance cost curve rising above *all* funds available for transportation within the next ten years. This situation was created by years of lavish capital expenditures which took little account of long-term expenses.) However unpalatable these facts are to proponents of the existing travel technologies, a closer examination shows they are indeed facts which will have to be faced.

Forces of Breakdown for the Highway Complex

Market-Saturation and Technological Exhaustion with the Automobile Industry. In the major study of the auto industry, one economist has flatly stated "The auto industry can be described as a technologically stagnant industry in terms of its product. Cars are not fundamentally different from what they were in 1946; very little new technology has been instigated by the industry."* He further commented that the automakers' ability to respond to new conditions, particularly new public concerns, was "not impressive."

Emma Rothschild, in her book *Paradise Lost: The Decline of the Auto-Industrial Era,* has attributed this failure of performance not only to oligopoly but to the underlying nature of the product. She compares the automobile industry to the 19th Century English textile industry, and concludes that the peak of productivity increases is long past, and that all the devices by which markets for the good can be widened and deepened have been fully exploited. Car ownership in the U.S. has grown from 7% of all American families in 1920 to over 80% today; second car ownership, as well, seems to have reached a natural limit (especially with the relatively rising costs of car ownership). She concludes that "The U.S. auto business now seems likely to follow the same historical course as these British industries--down to its present and expected troubles with slow growth, market saturation, management inertia, capital stagnation, and technological demoralization."**

While mass transit technology, new urban-oriented small cars, and other novel products might lend new vigor to the automobile industry, these have never been major profit sources for Detroit and the industry's current unwillingness or inability to shift toward them reinforces Rothschild's pessimistic views. While the point has not been

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*Lawrence J. White, *The Automobile Industry Since 1945* (Cambridge: Harvard University Press, 1971), p. 258.

**Emma Rothschild, *Paradise Lost* (New York: Random House, 1973), p. 174.

definitely established, it is worth considering that the automobile era industry will not respond particularly well to an era of new, more austere needs.

The Accumulation of Negative Externalities and Social Costs Generated by the Automobile. A nationwide awareness of the costs automobiles impose on society has grown steadily over the past ten years. It is no exaggeration to say that the direct losses in damage to humans, cars, and other property from car accidents is colossal. More than 55,000 people are killed every year, while ten times as many are seriously injured. (One recent study suggested these costs add 2.34 cents per mile to the cost of operating automobiles.)* But the external damages are equally high. Streets and parking facilities claim as much as half the land area of some cities (one-third is typical). Urban freeways have painfully displaced hundreds of thousands of families. The public expense (both capital, maintenance, and policing) of roads in the San Francisco Bay Area (based on a 12% social discount rate) amounts to 2.7 cents per auto-mile.** Pollution and noise costs have become a national issue, leading the Environmental Protection Agency to propose drastic reductions in car usage in metropolitan areas like Los Angeles and San Francisco. These costs have led many analysts to question whether auto diffusion and use would be so nearly universal if drivers were required to pay the full social cost of auto operation including congestion costs.*** If these costs were fully perceived and actually imposed, it is not clear that travel would display today's modal split characteristics.

It seems likely, in fact, that urban areas would experience a modal shift toward public transportation--particularly if mass transit service is delivered more effectively and efficiently in suburban corridors. A significant modal shift in metropolitan areas could have important consequences for intercity travel. If auto ownership rates decline, bus and air traffic could increase due to the unavailability of personal transport. If the auto is changed dramatically to conserve fuel or reduce pollution, the resulting "urbanmobile" might be less than amenable for over-the-road travel purposes.

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*Ted Keeler, "On the Average Costs of Automobile Transportation in the San Francisco Bay Area" (Berkeley Economics Department, April 1974), p. 10.

**_Ibid_, p. 25.

***For other studies of the social costs of autos, see John Jerome, _The Death of the Automobile: The Fatal Effect of the Golden Era, 1955-1970_ (New York: W. W. Norton, 1972) and Ralph Nader, _Unsafe at Any Speed_ (New York: Grossman, 1965).

The Advent of an Era of Austerity and the Consequent Need To Shift Resources from Consumption to Capital Investment. Spokesmen for business, ranging from *Business Week*, *Fortune*, and the *Wall Street Journal* to Treasury Secretary Simon and Chase Manhattan board chairman, David Rockefeller, have been constantly declaiming that the U.S. currently faces a serious capital shortage. In a speech to the Detroit Economy Club, Rockefeller recently blamed part of the U.S.'s international competitive difficulties on the failure to plow sufficient resources back into capital investment. Chase Manhattan studies suggest a shortfall of more than 30% in needed capital in the next decade. He and other business leaders have pinpointed two key places from which to find this capital: the sometimes extravagant affluence of the American standard of living and the growing scope of state expenditures, particularly welfare-oriented transfer payments.

To the extent that national economic policy heeds these business warnings and shifts expenditures from consumption to basic investment, the consequences for the car-oriented society are quite serious. The car is, as noted, a primary element in the affluent American life-style. Reducing its role and substituting more collective, less costly forms of travel (public mass transit) would reduce the amount spent in this area and free it for investment. In addition, highway expenditures currently run more than $24 billion, much of which is of dubious cost effectiveness. If one counts indirect social and public expenses, the figure is of course higher. Street and highway-related public expenditures are thus a prime candidate for cutbacks in the public sector, and notwithstanding intense political pressures, the past two Presidents have impounded highway money as a result. National policies of this general sort seem destined to become more, rather than less, imperative in the future.

The Shift in Control of World Oil Resources to OPEC Nations and the Consequent Rise in Oil Prices. Oil and gas costs make up roughly one-eighth of the total cost and about one-quarter of the private costs of operating a car. They are, nevertheless, one of its most rapidly rising elements, owing to the near-revolutionary shift in power over the pricing and distribution of oil to the OPEC countries. While the general subject of the international politics of oil is perhaps more fraught with uncertainty and danger than any other subject considered here, it is probably safe to say that the U.S. will never return to an era of cheap oil and gas. If anything, the costs are likely to rise even more rapidly in the future. The only way the U.S. economy can react is to reduce energy consumption; toward this end, automobile gas consumption is a prime target. While U.S. policy has not yet been authoritatively formulated (high gas taxes, rationing, and other alternatives are possible) any likely option will reduce car driving and encourage the substitution of smaller, more efficient cars and more energy-efficient modes. More than anything else, this will mean public carriers will become more attractive as compared to large gas-guzzling autos.

Rising Antagonism on Automobile Production Lines. While shop-floor militancy has risen in all production industries, it has been especially noticeable in the automobile business. Detroit's labor-management relationships have been two-sided: generally smooth between the United Auto Workers (UAW) and the Big Three, and distinctly rocky on the factory floor. Absenteeism, sabotage, wildcat strikes, informal attempts to slow down the pace of production, foreman-worker antagonisms, violence, and radical organizing efforts are all rife in Detroit. A Detroit jury recently refused to convict a black line worker who went home, got a rifle, and returned to the assembly line to shoot a foreman who the worker had claimed was harrassing him. The jury felt that conditions on the line were so intolerable that the worker was not responsible for his actions. In another incident, two black workers on a General Motors (GM) assembly line seized a control point and stopped production for several shifts. Their fellow workers strongly supported their demand that an alleged racist foreman be fired; though both GM and the UAW strongly deplored their actions, the foreman was indeed fired and the two remain in the GM workforce.

To counteract such tendencies, GM has developed a special division to control production: the General Motors Assembly Division (GMAD). GMAD was responsible for organizing work at the Lordstown, Ohio, Vega plant. Lordstown was an experiment to see if a more rural setting, massive new production technologies, and a pool of young, white, small-town workers could be the answer to production difficulties in Detroit. The answer came during a now-famous walkout against GMAD's tactics at Lordstown. While perhaps not as highly politicized as Detroit's black workers, the Lordstown local of the UAW proved to be every bit as militant and stubborn.

The implicit lesson seems to confirm the findings of sociologists' studies of work in auto factories: the auto production line is one of the most alienating places to work in our society, and it breeds intense hostilities no matter what the particular ingredients are. While few really comparable statistics have been gathered, the severity and frequency of recent incidents seems to suggest this problem is getting worse, not better. The consequences for the auto-oriented society also seem fairly clear. Labor antagonisms will hinder efforts to raise productivity and make autos cheaper. Instead, these antagonisms may result in more poorly constructed, and hence ultimately more costly automobiles. They raise as well the issue of whether society wants to require as much of this unpalatable and unfulfilling work as it presently does.

The Shift in Federal Investments Away from New Highways Toward Urban Mass Transit. In response to some of the factors described above, and to political pressures as well, federal transportation policy is undergoing a gradual but steady transformation. Relatively less is being spent on new highway construction, relatively more on

maintenance, and new expenditure categories for urban mass transit capital and operating expenses have been opened. While this latter category has not yet outweighed Trust Fund expenditures, if past trends continue, it may do so within the decade. Contested urban freeways, for example, may now be converted into mass transit funds, and on the order of $5 billion to $6 billion may thus be shifted. The rapidly rising costs of highway maintenance also suggest that few new highways (a key stimulus to additional car usage) will be built, for maintaining existing capital investments will impose an overriding demand on Trust Fund capabilities.

The net result of this policy shift will also be to cut down the rate of growth of demand for cars and to make alternative modes, especially buses, more attractive. While this impact will be most clearly felt within metropolitan areas, if car ownership and usage begins to subside, a secondary effect will also be felt on intercity transportation. Families without cars will look to buses, car rentals, and (for the more affluent) air travel.

The End of the Love Affair with the Car

The foregoing discussion examines difficulties either internal to the automobile production-distribution-consumption system or stemming from that system's location in a rapidly changing world economic environment. The system has also been sustained by a particularly American life-style--the love affair with the car--and a particularly strong political coalition. These two more or less external elements of the system and its social and political bases are also changing. While these changes are less susceptible to being operationalized and quantitized, in the end they are equally real in their impact on the auto-industrial complex.

Urban freeway opponents, the ecology movement, and consumer militancy provide the most obvious examples of how the political basis for the car-oriented society has been eroded. Once faced with little or no opposition, the highway lobby now seems challenged from all sides. Particularly in the cities, where freeway construction damage, negative externalities, and fiscal costs of the car society have been concentrated, and where those least likely to own or use cars (the poor, the elderly, and the handicapped) are *also* most highly concentrated, the car is no longer king.

In Boston, San Francisco, New York, and many other major cities, urban freeways have been halted and a massive clamor has arisen to shift freeway money to mass transit uses. (Hence, the federal policy change for which big city mayors and urban governors lobbied

vigorously.)* San Francisco's Mayor Alioto, for example, vowed that new freeway construction would take place over his dead body, and many other mayors would doubtless echo this sentiment, chambers of commerce notwithstanding. In suburban areas, ecology activists and opponents of suburban sprawl have been similarly effective in halting highways and promoting mass transit alternatives.

This political development, which has been at least partly successful in challenging the dominance formerly enjoyed by the Federal Highway Administration and the state highway departments, has been mirrored by a shift in thinking among policy and academic elites. In fact, professional sentiment, antihighway political initiatives, a newly invigorated mass transit lobby (the American Public Transit Association), and newly established urban mass transit bureaucracies are forging a new consensus in favor of mass transit capital investments. The San Francisco Bay Area has recently completed a commuter rail rapid transit system, another is under construction in Washington, D.C., and advanced planning has occurred in Atlanta and many other cities. The Urban Mass Transit Administration has spent roughly $1.35 billion over FY 1974, much of which has gone into bus systems. Nowhere is this more apparent than in California, once the citadel of car culture, where Sid McCausland, Deputy Secretary of the Business and Transportation Agency, promised that the Brown Administration would attempt to "pry the king of the road out of his car." CALTRANS is undertaking an experiment on the Santa Monica Freeway (one of the busiest in the world) in which one lane will be used for commuter buses and access to the other lanes would be metered in such a way as to strongly discourage usage. Whether or not CALTRANS can persist in this course, it is a 180-degree turnabout from the days when the state's freeway system was originally constructed. These policy changes are backed by growing academic literature which suggests ways to limit auto usage and encourage the shift to mass transit.**

Once again, though these policies have their main impact on intracity travel, to the extent that they are successful, they will have an inevitable secondary impact on intercity travel patterns. Cars designed to cope with urban requirements are not likely to be suitable for high-speed, long-distance travel. To the extent that carless life patterns become not only possible but widely desired (and this is the Brown Administration's avowed aim), the intercity implications are plain.

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*For a discussion of freeway fights see Alan Lupo et al., *Rites of Way* (Boston: Little Brown, 1971), and Kenneth Geiser, *Political Processes of Urban Freeway Controversies* (Cambridge: MIT Urban Systems Laboratory, 1970).

**See, for example, John Kain, "How to Improve Urban Transportation at Practically No Cost," *Public Policy*, Vol. XX, No. 3, Summer 1972.

Another trend in social life reinforces this change in professional sentiment and political-bureaucratic practices. If the suburban way of life, with the demand for car travel implicit in it, has not yet perished, it is certainly not expanding with anything like the vigor of the 1950s and early 1960s. Birth rates and family formation rates have fallen, and young single people, particularly the kind of managers and professionals who would formerly have provided a principal source of suburbanites, have been showing a distinct tendency to locate in central cities. This may mean only that suburban families will get formed slightly later in the life cycle; but in the aggregate, it also means less reliance on cars and car-oriented mobility (and likely more on air travel). Indeed, it may well be that much of the increase in air travel (particularly nonbusiness air travel) comes from exactly this source.

Similarly, the auto is becoming a progressively less important status symbol and consumption item in America's great middle culture, at least in part because its defects, drawbacks, and costs are becoming pressingly apparent. Once more California seems to be pointing the way. In place of the highly sophisticated machines Tom Wolfe described as "Tangerine Flaked Streamlined Babies," the youth of California have turned to 1956 International Harvester vans capable of at most half the speed. Jeeps, trucks, VWs, and similarly sturdy and serviceable vehicles have become the byword.

While it is hard to specify how these changes in popular sentiment and life-style will affect the use of cars and therefore the demand for different types of intercity travel, at the very least one implication emerges. If these trends become prevalent, the demand for new autos and large amounts of high-speed intercity auto travel will diminish. In its place with be either air travel, or more sedate travel organized in a public fashion (that is to say bus travel and individuals gathering together to ride in vans or similar vehicles).

In other words, a highway- and auto-centered transportation policy consensus has broken down in the last decade. So too has the political coalition which backed it. In its place a new professional consensus, backed by a new lobby of transit systems, transport workers, and mass transit equipment manufacturers, and propelled by substantial political conflicts over highway policies, has emerged. In parallel, new life-styles which are much less dependent on the automobile have also emerged. For some, these life-styles are urban and middle class; for others they are compounded of many marginal elements. But in both cases they point to less reliance on the auto generally and less use of it for intercity travel.

Of course the auto-based suburban life-style remains predominant, and this fact adds an interesting twist to the demand for mobility. If the earlier discussion of the forces of breakdown internal to the automobile-industrial complex is correct, then the political pressure to keep the auto a viable answer will mount sharply over the next

few years. Systemic imperatives make the auto an increasingly harder answer to sustain; on the other hand, a whole life-style has been built upon it. It is a life-style which cannot be shrunk in scope and scale without great protest from those who have become accustomed to it. It is therefore likely that society will find some substitute for the auto which allows a smooth transition from an era of affluence and suburban expansion to an era of denser, more concentrated development. The growth of suburban condominium developments with privately maintained bus links to work centers suggests how this may be accomplished. The very strength of the suburban dream may therefore add fuel to the search for a good substitute for the individually owned automobile. Some substitute is necessary, but it will need to be one that allows suburban life-styles to continue, if at an abated tempo.

The Issues to be Faced

Let us assume for the moment that the gist of the foregoing argument is correct. This is not an unreasonable conclusion to make, and it is one which even the presidents of the auto corporations now find themselves accepting. (*Automotive News* wrote that "The automobile industry is suffering the slings and arrows of outrageous fortune to a greater degree today than at any time in its history.") What are the policy choice implications?

The first is that some substitute to the car will need to be found. This substitute will have to have certain properties which make it less vulnerable than the auto-based mobility system, and yet make it an attractive choice to the auto-based system given the needs and political demand for travel outlined above. In particular, any reasonable choice will have most or all of the following characteristics.

1. They will not impose major new demands for social capital or unproductive government expenditures.

2. They will not abandon highway capital investments, but probably use them in a slightly different way.

3. They will conserve on energy costs and per-mile private costs of operating the mode.

4. They will reduce the social, pollution, and congestion costs now imposed by the automobile.

5. They will tend to concentrate rather than further disperse metropolitan development.

6. They will tend to be organized collectively, and quite likely be financed publicly.

7. They will be shaped especially to serve:

   a. Low wage workers whose mobility has been impaired by the overall crisis, but whose mobility is essential, and

   b. Middle class commuters whose suburban life-style is both deeply ingrained and progressively less tenable.

These characteristics follow directly from the previous discussion. While they seem most clearly directed at intracity transportation needs (and this, indeed, is the locale in which most travel happens), they also apply to intercity transportation modes. Indeed, the more they apply to intracity travel behavior, the less likely that the car can remain as the principal intercity travel technology.

A second implication is also clear from this list of criteria: radical new technologies are out. Our society cannot afford them given its current straits, and they face many of the other difficulties now plaguing the auto industry. They would not only waste existing capital investments, require large amounts of new funds, and carry high risks, but they seem destined not to provide the kind of car-substitute needed.

Instead, something which fairly closely matches existing technology, but which does not have its drawbacks, seems the most likely and most wise alternative. For shorter-range trips, including intracity trips, bus or bus-like technologies (dial-a-van, rental cars, jitneys, etc.) and smaller, safer, and more efficient cars seem to provide the answer, while cheaper and less energy-consuming air travel technology responds to the need for longer-distance travel. This would make an intercity trip from one relatively car-free environment to another possible, and within each of these environments, a relatively high degree of mobility would prevail.

This set of solutions avoids some key problems: it would not set high capital or government expenditure requirements, it would involve fewer damages to individuals and environments, and it would tend to concentrate development and reduce the flamboyance of everyday life-styles without imposing severe hardships and generating intense conflict. It would also reduce energy costs, reduce the amount of vehicles which would be required (and probably reduce tension on the production line, if aircraft production lines offer any useful comparison to car production lines), and facilitate the policy and life-style shifts currently under way. For many it would even increase the amount of mobility enjoyed, for the car has adversely affected the few, while it has increased mobility for the many.

In summary, it appears that substantial changes in intercity travel patterns may well accrue from America's changed domestic and international economic and political position. These forces will require a decrease in auto-related individual consumption and lead to

the gradual but steady substitution of more collective, less energy- and cost-vulnerable technologies. While smaller and better cars may provide part of the answers for urban travel, even they would face many of the problems sketched out above. The best kind of answer will not, in all probability, depart much from what we know, nor will it abandon existing infrastructural investments. As prosaic as it seems, old and new versions of the bus, together with airplanes for long distance intercity travel, may well be the main beneficiaries of these developments. To the extent that the line of reasoning advanced above is found to be correct, they will also be the most appropriate modes in which to invest in technological advancement.

XIX. ELECTRIC HIGHWAY VEHICLES: A WAY TO SAVE OUR MOBILITY, AIR, ENERGY, AND FORTUNES

by

Richard B. Fradella

ABSTRACT

This paper analyzes the operational, engineering, energy and resources, air pollution, safety, and economic aspects of electric road vehicles (EVs) and highway accommodations to permit comprehensive use of them.

EVs are now restricted to special applications by the power, energy, and charging-rate limitations of portable batteries, and by highway systems that exclude energizing facilities en route.

With highway accommodations, portable energy limitation can be readily circumvented. Freeway electrification would provide ideal complementary power en route.

With 80% of U.S. road travel in EVs, U.S. petroleum needs would be cut 32%, and total energy needs about 10%. Air pollution would be reduced 50% nationwide, and 90% in places like Los Angeles. Energy-saving EV weight reductions would not compromise passenger safety, as inexpensive EV electronics would prevent vehicle crashes.

Owner-driven electric cars would offer an attractive, low-cost alternative to gasoline engine autos. Electric buses can combine neighborhood stops with rapid travel on electrified routes, without downtime for recharging portable energy, and would not need depots or depot parking lots.

Long, high-speed parts of a trip would be traveled on electrified freeways. A pair of electrified strips installed on the surface of selected freeways would furnish power to EVs through rolling/sliding contact, at speeds of up to 70 to 80 miles per hour.

EVs would automatically switch to portable power while traveling over disconnected sections, maintain alignment, and return to external power upon reaching normal electrified strips.

Contact wheels with wedge-shaped rims that fit into grooved electrified strips appear to be a good means to make contact with external power.

Working synergistically with the driver, machine-language road marking, other vehicle electronics, and stationary signaling equipment, electronics on EVs can facilitate in-transit energizing, control electric motors with regenerative drive, follow road instructions, automatically avoid collisions, and alert the vehicle's operator (or other appropriate drivers) to errors which might cause collisions.

Optoelectronic reading could be performed by a photodetector under the EV. Highway instructions, lane identification, and other information could be encoded by a series of stripes across the road surface, orthogonal to the centerline. Wrong-way driving could be prevented, legal

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cruising speed could be encoded on the road surface at periodic spacing, freeway exits and interchanges could be identified for photodetector reading, etc.

Collision avoidance electronics would be most effective on EVs traveling on electrified lanes, where segregation from unequipped vehicles would permit economical devices, without the need to install reciprocal devices on existing vehicles.

Conversion to 80% EV road transportation would require that U.S. electrical energy output be increased less than 15% over a reasonable implementation period.

Energy needed to generate electricity for EVs, with weight and driving conditions equivalent to contemporary engine vehicles, is about 40% less than in the petroleum currently expanded to produce gasoline for such vehicles.

A net reduction of 75 million tons of pollutants per year would result from replacing 80% of our fuel burning vehicles, plus the improvement occurring at the refineries which furnish gasoline.

Maintenance and depreciation costs would be less than those of fuel-burning vehicles.

XIX. ELECTRIC HIGHWAY VEHICLES: A WAY TO SAVE OUR MOBILITY, AIR, ENERGY, AND FORTUNES

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XXI. ELECTRIC HIGHWAY VEHICLES: A WAY TO SAVE OUR MOBILITY, AIR, ENERGY, AND FORTUNES

Richard B. Fradella*

We recognize the importance of flexible, portal-to-portal, comprehensive road transportation, the freedom of personal mobility it allows and the inherent energy, pollution, and safety problems that plague fuel-burning vehicles.

More than 100 million autos, plus over 20 million trucks and buses, are dependent on 40% of the petroleum (17% of the total energy) used in the U.S. each year. (Known U.S. oil deposits, plus anticipated discoveries, may be virtually depleted in 20 to 30 years. It is likely that petroleum fuel will be practically unavailable for most autos long before that, due to higher priority for agriculture, military, aircraft, petrochemicals, etc.)

Road vehicles cause 60% of air polluting emissions nationwide, and 90% in places like Los Angeles. Highway collisions and crashes claim 50,000 lives and injure millions in the U.S. each year.

A means of alleviating the above problems would be to equip our highways to accommodate electric road vehicles (EVs) that provide even better portal-to-portal and personal mobility, at lower cost than fuel-burning vehicles and without their negative consequences. This paper analyzes the operational, engineering, energy and resources, air pollution, safety, and economic aspects of this option.

EVs and the Cooperative Systems Concept

EVs are now restricted to special applications by the power, energy, and charging-rate limitations of portable batteries, and by highway systems that exclude energizing facilities en route.

Nobody is sure that practical portable energy devices, without complementary power en route, can ever provide the means for EVs to achieve the broad usefulness that inspired the phenomenal market success of the auto. However, with practical and profitable highway accommodations, portable energy limitations can be readily circumvented. Freeway electrification would provide ideal complementary power en route for an optimum overall road transportation system. The resultant combination

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*Richard B. Fradella is a circuit and systems design consultant located in San Juan Capistrano, California. While not a member of the study team, he contributed this paper for inclusion in the study reports in order that the point of view and arguments it contains would receive due attention. Mr. Fradella has degrees in electrical engineering from the University of California and the California Institute of Technology.

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of portable energy and in-transit energizing would be practical and broadly effective.

EVs might then be used for 80% of our personal, public, and cargo transportation. They would be especially effective where vehicular traffic is heavy, and able to reach destinations in less time than existing road vehicles, at lower cost.

With 80% electric road travel, U.S. petroleum needs would be cut 32%, and total energy needs about 10%. Air pollution would be reduced 50% nationwide, and 90% in places like Los Angeles. Energy-saving weight reductions would not compromise passenger safety, with inexpensive EV electronics to prevent vehicle collisions and crashes.

Accommodating EVs on our highways would not inconvenience owners of existing road vehicles or add tax burdens. Indeed, owner-driven and commercial EVs would soon become a substantial source of tax revenues.

With machine-language road marking, on-vehicle electronics can inexpensively control EV motors without need for interface hardware to improve safety and increase capacity on our highways by facilitating safe high-speed travel with close vehicle spacing.

These electric cars, buses, and trucks would share electrified freeways and existing city streets, garages, and parking lots, compatibly with existing road vehicles.

Owner-driven electric cars would offer an attractive, low cost alternative to gasoline engine autos. Electric buses can combine neighborhood stops with rapid travel on electrified routes, without downtime for recharging portable energy, and would not need depots or depot parking lots. Electric trucks can be driven inside buildings, for easy and secure indoor loading, and regenerative braking can handle long, steep grades without brake burnout hazard.

EVs--Somewhat Different, but More Useful

For short off-freeway trips, average speeds of 20 to 30 miles per hour (mph) with modest acceleration are acceptable to many drivers. Portable lead-acid batteries can provide enough power for this, at low cost. Nickel-cadmium batteries offer about double the speed and acceleration capability. Their higher price becomes more affordable with the small portable battery capacity needed to complement in-transit energizing.

Long, high-speed parts of a trip would be traveled on electrified freeways. A pair of electrified strips, installed on the surface of selected freeways, would furnish power to EVs through rolling/sliding contact during medium or long trips at speeds up to 70 or 80 mph. (See Figure XIX-1.) Storage batteries, recharged at home, at charging stations, or while traveling on electrified routes, would permit 50-mile excursions

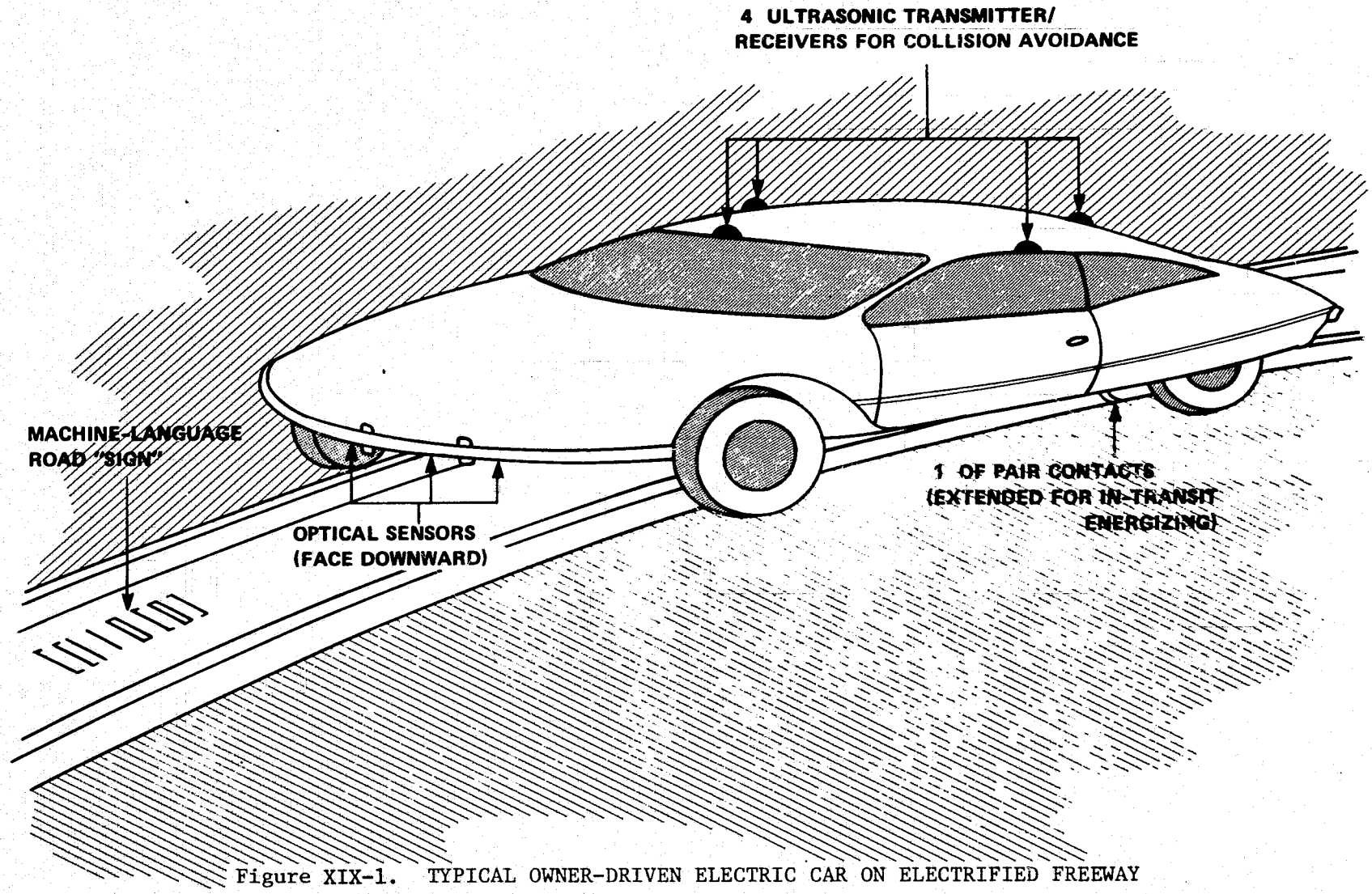


Figure XIX-1. TYPICAL OWNER-DRIVEN ELECTRIC CAR ON ELECTRIFIED FREEWAY

(at 25 mph with lead-acid batteries, 40 mph with nickel-cadmium) from these facilities.

A typical 50-mile trip--10 miles on city streets and 40 miles on electrified freeway--would thus take an EV with nickel-cadmium batteries 45 minutes; an EV with lead-acid batteries 54 minutes; an auto, traveling 40 mph on city streets and restricted to 55 mph on the freeway, 58 minutes.

EVs would enter and exit freeways conventionally, using portable power. When in acquisition range of the electrified strips, on driver command, EVs would automatically acquire and maintain alignment, with optoelectric servo-assisted steering. When aligned, EVs would extend a pair of rolling/sliding contacts to ride on the electrified strips. When not aligned within tolerance, contacts would automatically be retracted.

Electronics would facilitate safe, rapid travel, and prevent EV collisions by complementing the driver's perception and responses with prompt and unflagging sensor, computer, warning, and control assistance. Although instrument control would be subordinate to prompt and easy manual override, an audible signal could inform the driver when he overrides, warning him of a possible driving error.

Electric Motors for Propulsion and Regenerative Braking

DC motors, converting energy from electrical to mechanical (and vice versa) at 80% to 90% efficiency over a broad speed range would furnish propulsion and braking thrust. When braking, about 80% of EV kinetic and potential energy would be recovered--not dissipated as heat by friction brakes. EVs would even have inherent skid protection, since regenerative electric braking cannot grab.

Regenerative drive can accommodate high acceleration and stop-and-go traffic, and travel over hilly roads with practically no increase in energy consumption per mile driven. Indeed, the low average speeds which typify difficult driving would probably require less energy per mile than nonstop, high-speed freeway trips, where air drag consumes most of the propulsion power. Also, unlike idling internal combustion engines, electric motors do not consume power during momentary stops.

On early models, a DC motor (with conventional carbon-brush commutator) could be connected to the wheels by speed-reducing differential gears. Brushless transistor commutation may add up to 30% onto the first cost of the combined motor and its controller, but lifetime cost would be comparable, with no periodic maintenance. Later, motors might even be built into the wheels. Higher unsprung mass of motorized wheels and lower power-to-mass ratio at their relatively low speed are obstacles to this mechanization; but absence of gears, chains, belts, or mechanical drive linkages and low commutation rates are promising advantages.

Air Drag, Rolling Friction, and Power

Comparison data between auto and aircraft aerodynamic drag coefficients indicate that streamlined vehicle bodies could have air drag well under half that of today's typical auto. Contrary to their present image, EVs are particularly suited to streamlined body design: relatively low heat generation does not require as much convective air circulation, as is needed to remove heat from fuel-buring engines; undersides can be aerodynamically smooth, with no accumulation of toxic or explosive fumes, fuel, fluid, or oil to prevent a practical bottom inclosure. With existing body designs, air drag should be about 50 pounds at 60 mph for a personal-size EV, requiring about 6.0 kilowatts for propulsion. Future streamlining may reduce this to about 3 kilowatts.

Rolling friction is proportional to vehicle weight and inverse to wheel diameter, inflation pressure of pneumatic tires, and road hardness and smoothness. Good, steel-belted radial tires have about 30 pounds rolling friction total, for a 2,000-pound car on smooth, hard roads; this requires 3.6 kilowatts to maintain a 60 mph speed. Future weight reduction, tire optimization, etc., may reduce this to 2 kilowatts.

Other power required at 60 mph is: 1.0 kilowatts for 10% motor loss; 0.5 kilowatts for 5% motor controller loss; 0.1 kilowatts for all other electronics; and an average 0.5 kilowatts for passenger temperature control, lights, and miscellaneous occasional needs. Total electric power is about 11.7 kilowatts at 60 mph. On future improved EVs, power needs at 60 mph may be reduced to 6 kilowatts. (See Figure XIX-2.)

At 25 mph, air drag takes 0.5 kilowatts, rolling friction 1.4 kilowatts, motor loss 0.2 kilowatts, controller loss 0.2 kilowatts, and all other power requirements under 0.1 kilowatts. (Temperature control and lights are not used for typical short daylight trips.) Total power at 25 mph is then 2.4 kilowatts, normally from portable batteries.

Portable Power on Vehicles

The equivalent of 10 lead-acid batteries, weighing about 500 pounds total, would provide 2,500 watts for a 2.5-hour excursion, from home or other charging facilities or from electrified freeways. This 6,250 watt-hour portable supply, converted to motor output at 85% overall efficiency, would permit an excursion range of 70 miles at 20 mph or 65 miles at 25 mph, for a 2,000-pound EV on good roads with no net climb. Or it could power a 5,500-foot climb at about 1 mph, up a 30° grade, covering 2.1 road miles. Ten batteries could also furnish 40 kilowatts (for about 30 seconds). This power burst can accelerate a 2,000-pound EV to 60 mph from standstill in 15 seconds. (See Figure XIX-3.)

The slow charging and light use afforded by in-transit energizing should result in a typical battery life of three to five years, with 75% charge

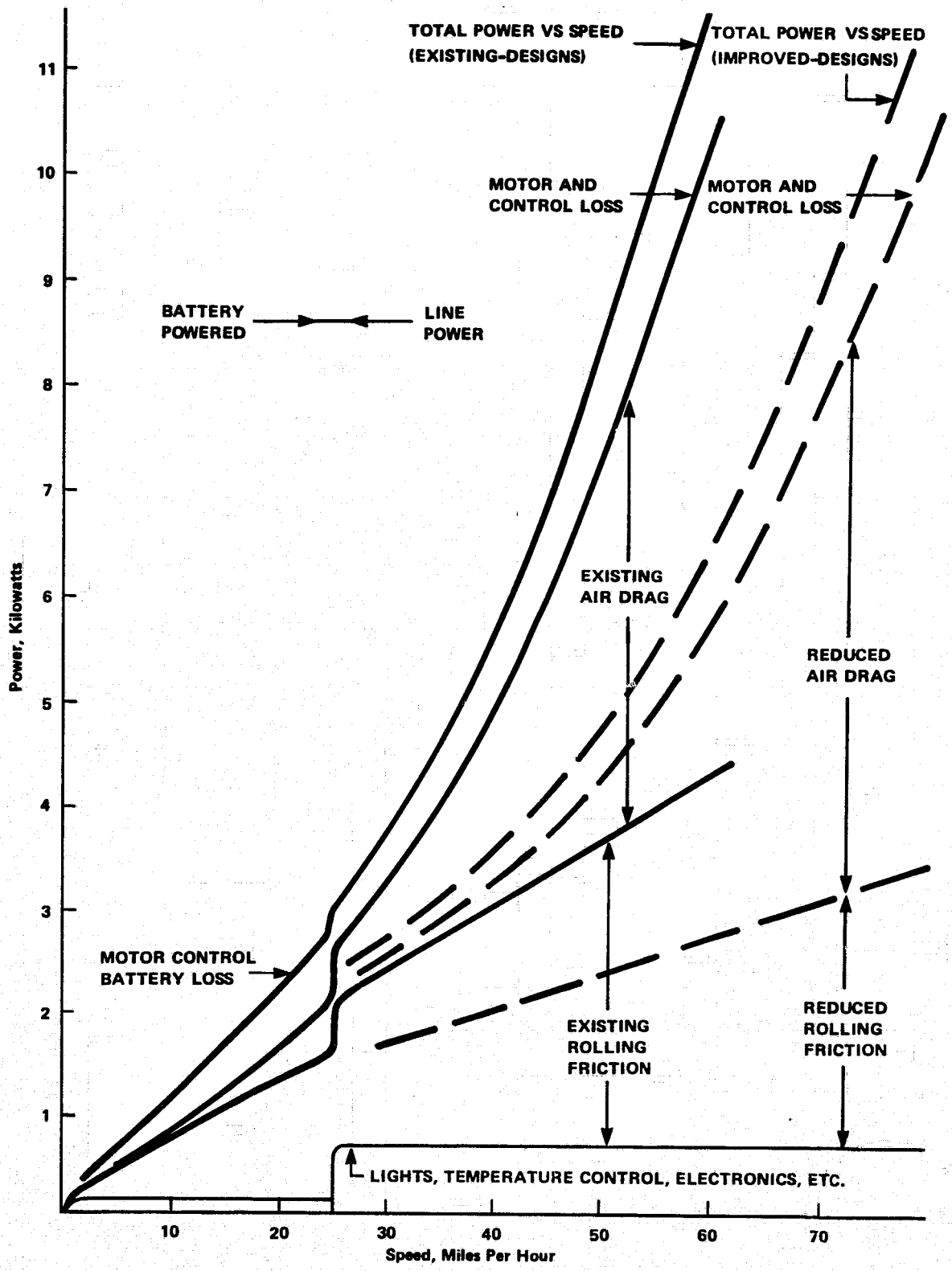
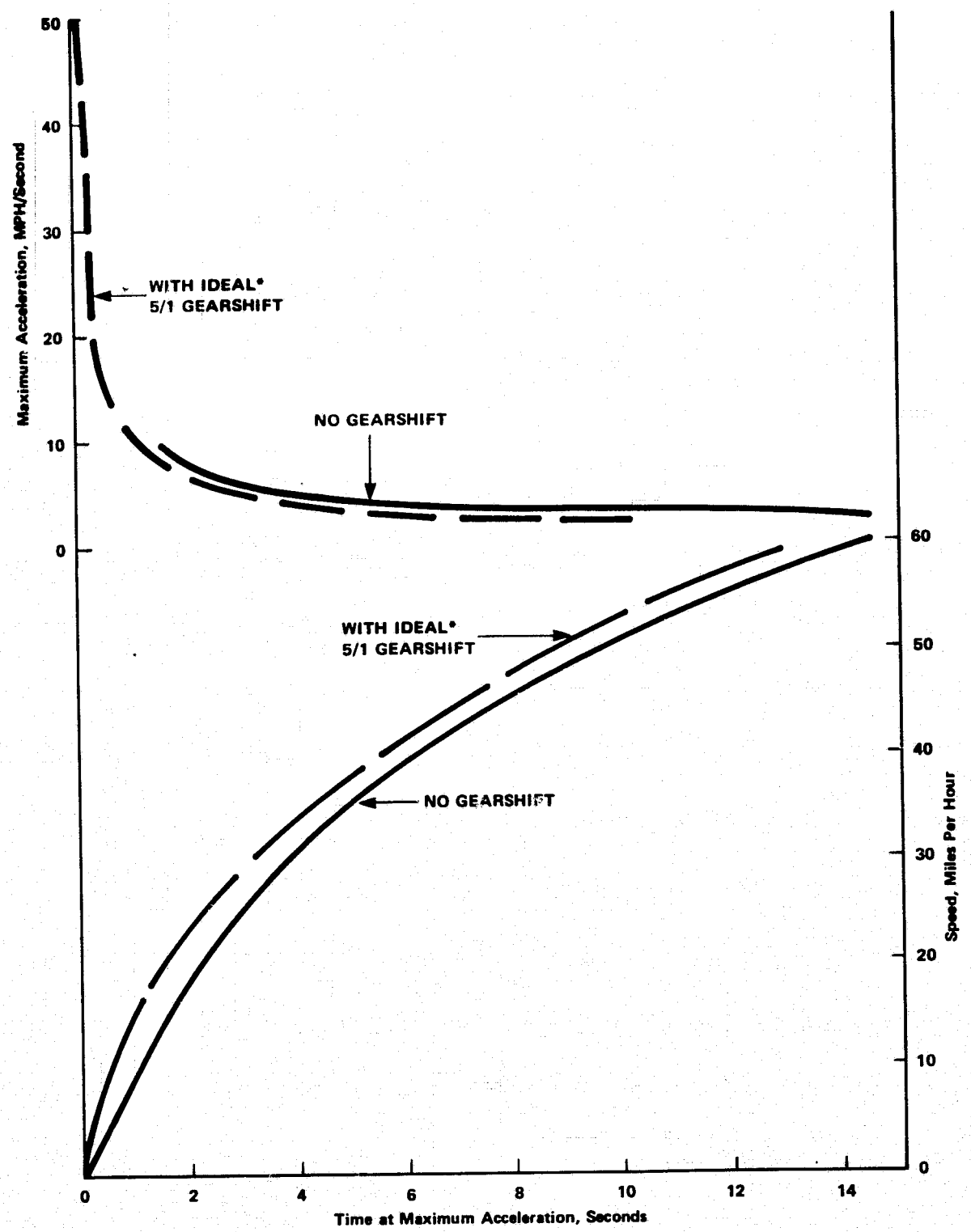


Figure XIX-2. POWER NEEDS VS SPEED OF EXISTING DESIGNS AND IMPROVED ELECTRONICS



*Assumes negligible acceleration drop while shifting gears, and neglects gearshift losses.

Note: Motor current limited by switching regulator controller from 0-15 mph without gearshift, 0-3 mph with 5/1 gearshift.

Figure XIX-3. ACCELERATION FROM STANDSTILL OF 2,000-POUND EV POWERED BY 10 LEAD-ACID BATTERIES (Rated minimum 40 kilowatts for 30 seconds)

retention per month of storage, and 70% overall charger-battery efficiency in daily use.

Of course, portable energy devices with higher power and energy density would improve EV performance off electrified freeways. Lead-acid batteries are the most economical devices now available. Nickel-cadmium provides about double the power, and costs about triple for equivalent energy capacity. As other devices become available, they can be used as replacements or complements.

Solar cells on cars, with a 4-square-meter-area facing, 1 kilowatt per square meter solar intensity, can provide about 500 watts for several hours daily. This is not enough to sustain typical cruising speed but is ideal to charge batteries and permit unlimited travel on roads not equipped to furnish external line power.

In-transit energizing would be a good complement to existing portable energy storage devices, as well as possible new developments. It affords a practical way to circumvent their limitations, allows lower curb weight to save energy off as well as on freeways, and minimizes any portable energy device crash hazard.

Power from Electrified Freeways

In-transit energizing would permit driving virtually unlimited distances at high speed over electrified routes without time out to recharge portable energy. Power from a pair of parallel electrified strips, about 1 meter apart, on one freeway lane (until the number of EVs in use warrants more lanes), would supply about 15 kilowatt per car (more for larger vehicles) for propulsion, battery charging, and incidentals at speed of up to 80 mph. The left (fast) lanes could be equipped first, with adjacent lanes electrified as required.

Low-voltage DC (less than +100 and -100 volts to ground) would suit transistor electronics; be compatible with batteries, electrically coupled flywheels, and solar cells; minimize insulation and shock hazard; and facilitate efficient regenerative power control with practical motor controllers.

The electrified conducting strips, in half-mile typical length-segments, could be installed on existing road surfaces with adhesive bonding material. Each segment would be electrically insulated from adjoining ones, so a shorted or overloaded section can be disconnected by automatic circuit breakers from normal electrified ones. Breakers could self-reset when the overload is corrected or might be reset by remote control.

Segments would be connected at both ends to subsurface, lateral feeder lines, which furnish DC power and strip continuity through the circuit breakers, located in service vaults on freeway medians. Typically, each

vault would house voltage step-down power transformers, rectifiers, the breakers, fault signaling equipment, and switchgear.

Power to the vaults can be purchased from an electric utility serving that region, transmitted to the vaults via high-voltage lines, and metered at the vaults.

Electrical continuity (through two series breakers) would allow DC power exchange between adjoining sections--also to adjacent sections across the freeway divider--so power could be efficiently exchanged between EVs for several miles along the freeway, traveling in both directions. On long, steep grades, downhill traffic would supply power to uphill traffic.

EVs would automatically switch to portable power while traveling over disconnected sections, maintain alignment, and return to external power upon reaching normal electrified strips.

With 5.5 square inch cross-sectional area, half-mile long copper strips, power loss in the strips will never exceed 10% of that delivered. This is based on 200 volts line-to-line, 75 amperes per vehicle, at 50 feet minimum spacing.

There are significant differences between this low-voltage electrification (which would supply a somewhat constant, distributed load) and the 25,000 volts commonly used for locomotives (which must supply great power at infrequent intervals to a concentrated load). The conductivity of electrified strips for EVs is a more important requirement, due to their high current. However, ease of insulating them and the relative safety of their low voltage permits surface strips that do not need supporting structures, do not compromise aesthetics, and do facilitate a convenient method to electrically connect and disconnect a continuous progression of EVs. Appropriate design and maintenance should provide the requisite high-contact area, steady pressure, and high surface conductivity needed for low contact resistance without sparking and pitting, despite exposure of the copper surfaces to moisture, salt spray, and corrosives.

Contact wheels with wedge-shaped rims that fit into grooved electrified strips with their other surfaces electrically insulated appear to be a good means to make contact with external power. This design should result in minimal abrasive wear of both contact surfaces, low friction drag, and quiet operation. (See Figure XIX-4.)

Electronics on Vehicles

Working synergistically with the driver, machine-language road marking, other vehicle electronics, and stationary signaling equipment, electronics on EVs can facilitate in-transit energizing, control electric motors with regenerative drive, follow road instructions, automatically avoid

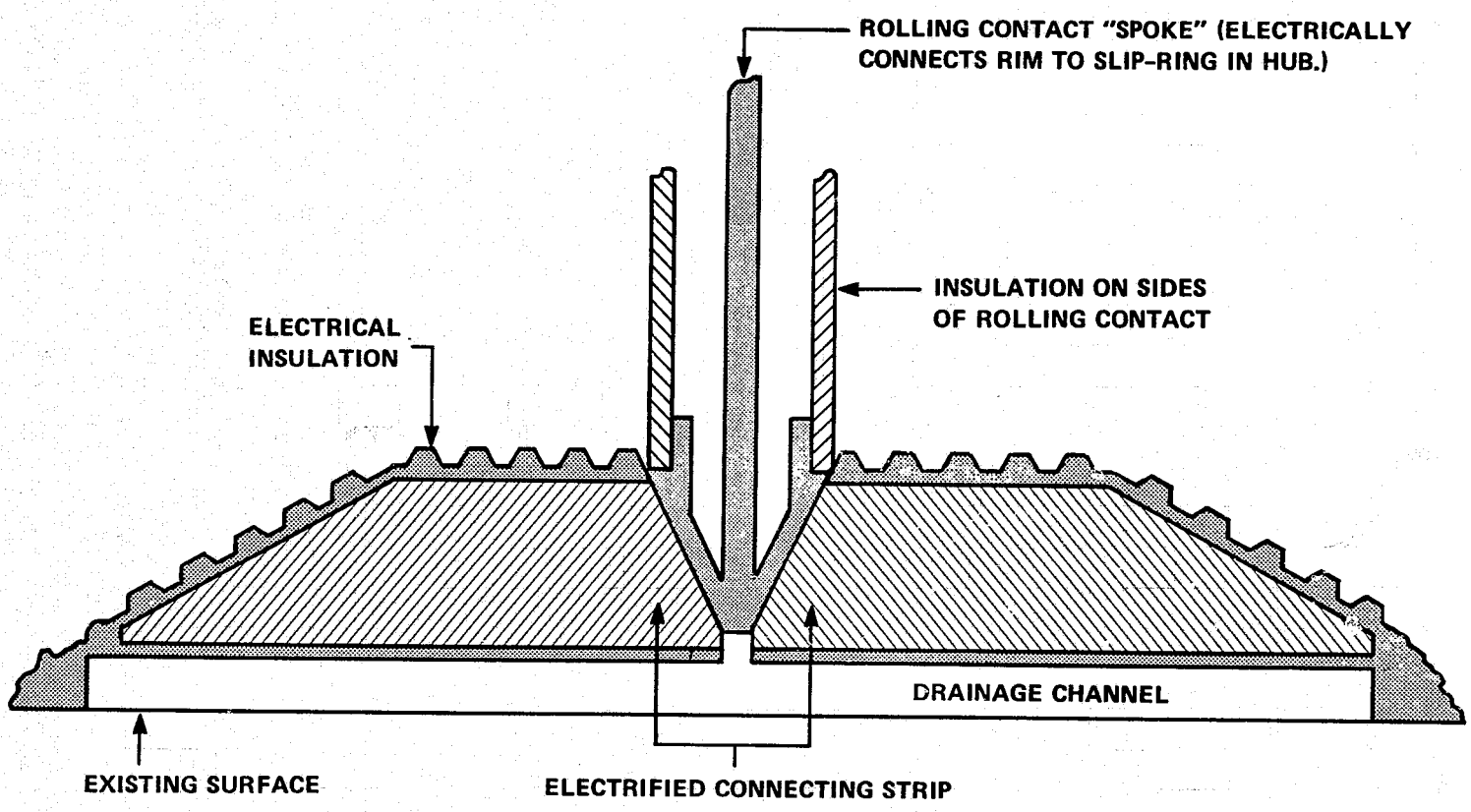


Figure XIX-4. ROLLING CONTACT ON ELECTRIFIED STRIP ON FREEWAY (Cross-sectional view)

collisions, and alert the vehicle's operator (or other appropriate drivers) to prevent errors which might otherwise cause collisions.

Failure of any electronic circuit would not cause loss of vehicle control. All electronics would have mechanical or fail-safe electrical backup with manual control. Automatic controls would assist the driver, not replace him.

Complex functions can be performed inexpensively and reliably with multi-element chip integrated transistor circuits, handling low power (less than 1 watt) at low frequencies (below 1 megahertz). All EV electronics can be implemented with off-the-shelf components, though special-purpose parts would reduce costs significantly in production quantities. They include custom integrated circuits and high-current transistor switches.

Battery charging would be controlled by an adaptive duty cycle (ON/OFF time ratio) circuit switched at 10 to 100 kilohertz.

The motor controller would provide smoothly variable power to (and from) the motor for forward and reverse drive, with regenerative braking, by similar duty cycle control.

An optoelectronic servo would acquire and hold alignment to the electrified strips on freeways. The surface between the strips could be coated white, to provide a continuous stripe, about 30 inches wide, with comparatively high reflectance against a dark background surface. Two photodetectors at each side of the vehicle would sense road position relative to this stripe. Illumination of the road under the detectors could be modulated by a light source flashing at about 100 kilohertz. Synchronous demodulation of the detector signals would sense comparative reflectance and reject false indications due to shadows, stray light, etc. The acquisition range for this self-steering servo would be the width of the stripe: about 30 inches on each side of center. The two detectors at each side would provide an error signal for servo steering and automatic deployment of the vehicle's rolling/sliding contacts.

Turning rate could conveniently be proportional to vehicle speed, so a constant ratio between steering loop time-lags is maintained over a wide speed range. This should contribute to optimum servo stability and dynamic response. Servo steering angle and turn rate can be limited to accommodate only freeway curves. This insures that signal loss or servo malfunction would result only in the vehicle drifting from center; a condition safely and easily handled by the driver resuming manual steering control, or by simple override action.

Servo steering could be deactivated when the driver exerts a manual steering wheel torque above a preset value, in either direction. The servo would not affect manual steering and would remain inactive until instrument tracking is again activated.

Road Marks for Literate Vehicles

Optoelectronic reading could be performed by a photodetector under the EV, with the road surface illuminated by a synchronous flasher--identical to those used for servo steering. Highway instructions, lane identification, and other information could be encoded by a series of stripes across the road surface, orthogonal to the centerline. This "sign reading," combined with memory, logic, audio communication with the driver, ultrasonic transmitters and receivers, and linked to the motor controller, provides unambiguous collision avoidance, driving convenience, and even presents further opportunities to save enrgy, by permitting lighter vehicles without compromising safety.

"Wrong way" driving could be prevented. When this warning appears under the vehicle, optoelectronics would detect it, alert the driver, and brake the EV's forward motion, so it would not proceed into oncoming traffic. Normal operation might be restored by driving backward over the warning.

Legal cruising speed could be encoded on the road surface, at periodic spacing. It would be read and held in memory for cruise control, and automatically updated by subsequent readings. In the absence of manual override or collision avoidance priority, cruising speed would conform to road instructions without need for driver attention.

Freeway exits and interchanges could be identified for photodetector reading, so the driver would be reminded when approaching a preselected one. Traffic at intersections might be more safely controlled by redundant ultrasonic signals, operating simultaneously with conventional signal lights, aided by road markings at "decelerate" and "stop" positions. Optoelectronics could furnish lane identification, position relative to the center of the lane, and reference position along the length of the freeway for collision avoidance electronics with one-way signaling.

Lest it be assumed that electronic driving aids could just as easily be added to heat engine vehicles and ought not embellish the fundamental concept of battery electric vehicles with in-transit energizing, the following specifics should be noted which illustrate the relevance of each feature to the total system concept.

Self-steering maintains precision alignment for practical in-transit energizing. Its safety and convenience aspects are attractive secondary benefits.

Adding error/collision avoidance to EV motor control requires little more than "plugging in" these devices to the motor controller. Conversely, the electromechanical actuators, mechanical linkages, and additional electronics and sensors needed to automatically control a fuel-burning engine and friction brakes would cost at least as much as the basic collision avoidance electronics described here. Because

electronics can prevent most collisions, important secondary benefits can be achieved (greater acceleration, speed, and range on battery power, plus reduced energy consumption) by cutting EV weight without sacrificing safety. Furthermore, collision avoidance electronics would be more effective on EVs traveling on electrified lanes, where segregation from unequipped vehicles would permit economical devices, without the need to install reciprocal devices on existing vehicles.

Collision Avoidance Electronics

A priority signal to the motor controller of one EV following another, based on their speed, closing rate, and spacing, can avoid rear-end collisions by maintaining spacing that is never less than worst-case deceleration distance required to stop the rear EV.

As existing vehicles are replaced by new ones with collision avoidance electronics, more than one lane on most freeways could be used by vehicles equipped with it. Then, lane recognition would be essential to avoid false alarms from vehicles in adjacent lanes and dependably receive signals from vehicles in the same lane (even when not aligned). This can be accomplished with transmitters on vehicles which radiate a different frequency for each lane of a multi-lane freeway, in accordance with optoelectronic lane identification from machine-language road marking. One transmitter and receiver would face forward. A second set would face to the rear. A third and fourth set might face left and right, to alert a driver if he attempts to move into a lane occupied by a vehicle directly alongside. Forward receivers would be tuned to rear transmitter frequencies, rear to forward, left to right, and right to left.

Distance measurement to the vehicle ahead in the same lane (which may be required without benefit of lane marking) could be provided by rear transmitter signal modulation, in response to periodic pulse transmission from the following vehicle. This would provide range data by two-way signal propagation delay.

Relative speed from Doppler frequency shift would be integrated to provide continuous ranging data, so distance reckoning intervals can be several seconds (or even longer) since the intervals need only establish a reference position (i.e., the initial integrator setting and integrated error correction) for the Doppler shift integrator, which would receive continuous data.

One-way rear transmitter signals from vehicles ahead in adjacent lanes would permit monitoring their positions, too. This feature would facilitate safe, effective, and smooth lane mergers by automatically providing safe spacing to the merging vehicle, with predictable "courtesy" and mathematical precision. And, drivers would be automatically warned within milliseconds, if they attempted an unsafe lane change. The nearest

endangered vehicle's forward transmitter would serve as an electronic horn, alerting only the erring driver, without disturbing others.

One-way signal monitoring would require machine-language road marking of freeway lanes at, say, one-mile intervals, to establish relative position along the length of the route. Wheel rotation data would provide continuous position data for transmission by pulse-code-modulation (PCM) synchronized to possible "echoes" from a following vehicle's transmitter. Relative speed would be continuously available from Doppler shift and PCM reference transmitted at intervals of several seconds. Vehicles further than a half-mile ahead would be out of collision and signal range, so position reference coding can be repeated, say, every two miles.

Lack of lane identification on remote roads or city streets should not be troublesome, as less-traveled roads probably have only one lane of traffic in each direction, and on crowded city streets, ordinarily close spacing would minimize false alarms between vehicles in adjacent lanes. Nevertheless, the motor control function of the collision avoidance electronics should be inactive with only driver alert signals provided where lane identification is not available. An occasional false alert is a nuisance, but braking in response to ambiguous data introduces unnecessary hazards that are best avoided.

Ultrasonics appears to have substantial cost and reliability advantages over microwave. Wavelength is about a millionth that of electromagnetic of the same frequency, so equivalent directivity could be achieved with smaller transmitters and receivers, operating with relatively low frequency (below 1 megahertz) circuits. Percentage Doppler shift is almost a million times greater than electromagnetic, so relative vehicle speeds could be easily detected by one-way signaling. (With an ultrasonic frequency tolerance of 0.1%, closing rate can be measured to an accuracy of 0.7 mph.) Acoustic wave propagation velocity would add less than 10% to the safe following distance at 70 mph, 5% at 35 mph, etc.

With active transponder "echo" ranging and one-way signaling, vehicles could radiate low signal power and yet have high signal strength at receivers.

The expected cost to include this collision avoidance feature on each EV is less than $200.

Other Possible Improvements

Electric window operators, thermal insulation, and sun-screening windows are more important to these EVs than to present fuel-burning vehicles. Closed windows will probably be necessary for low air drag at high speed. And power needs for air conditioning must be minimized, especially when powered by portable batteries.

With windows closed on freeways, passenger air could be effectively filtered at negligible cost. It is also important (and very practical on EVs) to filter air circulated to the electric motors, batteries, and electronics.

Friction brakes would not be used for dynamic braking, except as a failure contingency. So, electrically actuated friction brakes, which hold when de-energized and release when energized, could replace the cable connection and "parking gear" on EVs for fail-safe braking that is easily interlocked with other operator controls.

Brake actuator circuits could be ganged to the main power switch and brake pedal, so the friction brakes would be engaged by turning the main switch off or forcibly flooring the brake pedal for a "panic" stop. These interlocks would end problems like engaging the "parking gear" with the vehicle in motion and forgetting to set or release the cable. Consistent preset brake pressure with electric actuators would hold EVs reliably, without depending on the operator to apply correct cable tension. Friction brake linings, used only for holding, should be virtually free of wear and resulting wear products (e.g., asbestos dust).

Energy Conservation and a Shift to Alternate Sources

Conversion to 80% electric road transportation would require that U.S. electric energy output be increased less than 15% over a reasonable implementation period (two to five years for orderly planning, development, demonstration, and tooling for EV production, plus about ten years for an equitable transition, with existing fuel-burning vehicles retired only after they have provided a normal service life, as determined by their owners).

By shifting our source for 80% of U.S. road vehicle energy from oil to other options, petroleum use in the U.S. would be cut 32%.

Energy needed to generate electricity for EVs, with weight and driving conditions equivalent to contemporary gasoline engine vehicles, is about 40% less than in the petroleum needed for gasoline. Design refinements will surely reduce future EV power needs, perhaps by 50%. Electronics would help to accomplish this. With safety emphasis shifted from heavy crash survivable vehicle bodies to practically weightless collision avoidance electronics, lighter EV weight would reduce rolling friction and other forces that consume energy. In-transit energizing would also help, by reducing the weight of its portable energy about 80%. Even before design refinements, EVs would enable a 6% reduction of total U.S. energy needs. Future improved EVs would probably save 10% to 12%.

Air Pollution

A comparison of present tailpipe and smokestack emissions in the U.S. with that for a hypothetical replacement of 80% of road vehicle-miles by EVs allows the following.

About 120 million road-vehicle tailpipes now spew 90 million tons of pollutants per year into the air over the U.S., gasoline refineries another 4 million, electric generating plants (50% coal burning) add 15 million, and manufacturing, heating, waste disposal, etc., bring the total to about 145 million tons.

To meet the energy needs of 100 million EVs, each traveling an average of 10,000 miles per year (i.e., 80% of U.S. road vehicle-miles), with 15% additional electric power generated by burning coal at present emission rates, total pollution from electric generating plants would increase less than 4 million tons per year. This is certainly a worst case assumption.

Straightforward arithmetic shows that a net reduction of 75 million tons of pollutants per year would result from replacing 80% of our fuel-burning vehicles, plus the refineries which furnish gasoline, with EVs powered by coal-burning generating plants. This would cut air pollution over the entire U.S. by about half. Of course, nonpolluting electric power plants that may be on-line in the future, as well as reduced pollution from other sources, would enable further improvements. And reducing pollution from gasoline delivery trucks, fuel and oil vapors, and asbestos dust from friction brakes will also help.

With dirty electric power plants sited outside population centers and EVs used inside them, conversion to EVs could cut air pollution about 90% over cities like Los Angeles.

Safety

Auto accidents claim about 50,000 lives each year in the U.S. plus millions injured and a financial loss estimated at $16 billion.

Electronics could prevent most types of serious accidents (e.g., rear-end collisions, head-on with "wrong-way" vehicle, side swipe, loss of control due to excessive speed, etc.).

With portable energy needs minimized by the availability of in-transit energizing, any possible crash danger from these devices is also minimized. Fire danger would be virtually eliminated, as EVs do not need to carry flammable or explosive fuel.

Electrocution, by contact with EV power or electrified strips on freeways, is highly improbable. The number of deaths by auto accident now are about 50 times the total number of all electrocutions throughout

the U.S., and chance of contact with electrified conductors at comparable voltage would appear to be much higher at home or at work than inside electric vehicles, or outside them on electrified freeways.

Better Mobility for Less

When costs for all electrical and electronic hardware in EVs are compared to gasoline or diesel vehicle costs, it is apparent that in production quantities EVs sould cost somewhat less.

Maintenance and depreciation costs would certainly be less than for fuel-burning vehicles. A battery replacement expense of about $60 per year for personal cars with in-transit energizing, air filters, and bearing lubrication should cost much less than the cost of auto tune-ups, brake relines, oil changes, coolants, oil filters, air filters, fuel filters, pollution reduction equipment, etc. EVs, operating without the combined heat, fluids, unfiltered cooling air, and grime of internal combustion engines should last much longer with correspondingly lower depreciation.

At a price of 7.5¢ per kilowatt-hour (about double most residential rates) for in-transit electricity with 12 kilowatts needed to travel 60 mph, energy would cost 1.5¢ per mile. At 60¢ per gallon, fuel for a comparable size gasoline engine car which can travel 20 miles per gallon, costs 3¢ per mile.

New Markets, New Business Opportunities

The potential U.S. market for versatile high performance EVs is about ten million vehicles per year, with annual sales of about $50 billion. There may also be a comparable export market.

Electric power sales would increase about $2 billion per year to supply electrified freeways, plus $1 billion per year to stationary charging facilities, including residential.

Lead-acid, nickel-cadmium, and perhaps other storage batteries installed in ten million new EVs per year would translate to retail sales of $2 billion to $5 billion. Replacement battery sales would climb with the number of EVs on the road and could pass $5 billion yearly, with 100 million EVs in service.

Electrically coupled flywheels, which don't need periodic maintenance or replacement, might become an attractive portable energy storage device for EVs, with over $5 billion annual sales.

Electrical equipment, electronics, and semiconductor manufacturers would share increased annual sales of at least $15 billion. This includes $5 billion for 20-kilowatt motors, at $500 each; $2 billion to $4 billion dollars for solid-state motor controllers; $2 billion for steering servos

and rolling contacts; $1 billion for collision avoidance electronics; $2 billion for battery chargers, meters, switches, small electric motors, etc., on EVs; $2 billion for electrified freeway and charging station equipment (power transformers, rectifiers, switchgear, etc.); and perhaps a few billion dollars for solar cells on EVs and solar generators alongside remote electrified routes.

To install one electrified lane on all 40,000 miles of U.S. Interstate highways within ten years would require 500,000 tons of copper each year. And, if ten million EVs are manufacturered each year, needing about 50 pounds more copper than a fuel-burning vehicle, EVs would need an additional 250,000 tons each year. These additional copper requirements would increase U.S. copper sales 45%, a jump of more than $1 billion per year.

Revenues for in-transit electricity could reach $15 billion per year. When priced so user cost is only half that for gasoline, return on investment for route electrification would be about 30% per annum (before taxes) if 25% of full capacity is sold. Lower prices or higher investor profits would accompany increased use (i.e., higher sales).

This investment prediction warrants a brief financial analysis. Estimated material, equipment, and installation costs for freeway electrification are:

Copper strips, pair (224,000 lb/mi @ 75¢/lb)	$170,000
Transformers, rectifiers, switchgear, breakers, etc.	100,000
Electrical insulation, adhesive	50,000
Two vaults, lateral feeders, misc.	80,000
Labor and/or machinery expense	100,000
Estimated total electrification cost per lane-mile	$500,000

Estimated annual operating expenses per lane-mile, to supply 25% of capacity:

Depreciation on $330,000 installation (copper not depreciated)	$ 16,500
Energy @ 1¢/kwh + losses @ 25% capacity)	42,000
Overhead, maintenance	50,000
Revenue collection expense, misc.	3,000
Estimated total annual operating expenses per lane-mile	$111,500

Gross income for in-transit electricity, at 7.5¢ per kilowatt-hour, would be $262,500 per year per lane-mile. Net income would then be $151,000 per year per lane-mile, at 25% capacity. Percentage annual return on investment for freeway electrification, used at 25% of capacity, would then be 30%.

If the 7.5¢ per kilowatt-hour rate continued as use increased to 50% of capacity, net income would be $361,500 before taxes, for a 75% per annum return on investment; so, we might expect rates would be reduced as use of electrified routes increased with the EV population.

These primary market opportunities would certainly be accompanied by major markets for related products and services, plus a stimulus to diverse business activities.

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XX. AUTOMOBILE DURABILITY

by

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ABSTRACT

Amid rising concern about automobile emissions, fuel economy, and safety, another aspect of the automobile's performance--durability--has received relatively little attention.

A car's physical durability is difficult to isolate from other factors--including economic and psychological considerations, climate, occurrence of accidents--that interact to determine the actual amount of time a car is used before being scrapped. The best, albeit rough, indicator of durability is actual useful life.

Registration and scrap data indicate that 10 years after a fleet of new cars is registered, roughly the same number are scrapped; of course, some cars last a longer, and some a shorter, period than 10 years. During the last decade, roughly 60% to 70% of the cars on the road each year have been 7 or fewer years old, and the average age of cars on the road has held steady at 5.5 to 6.0 years old since 1960.

Resource conservation is one benefit claimed to flow from an increase in a car's useful life; that is, a 15-year useful life (as compared with 10 years) lowers the rate of depletion of increasingly scarce resources. However, from the standpoint of resource use (at least those that actually become part of a car), there is no difference between one 15-year car and two 7-1/2-year cars.

A combination of economic, regulatory, and technological problems has prevented full, prompt recycling of scrapped vehicles: the relatively poor quality of auto scrap compared to the bulk of scrap used in iron and steel production; expensive technology required to convert auto hulks to usable ferrous scrap; differential tax treatment and freight rates of mining and manufacturing favoring newly extracted ore over recycled metals; restrictions on dismantlers' open burning of auto hulks; and legal complications in clearing title to, and asserting government jurisdiction over, abandoned vehicles on private land. Auto scrap comprises only 9% of total scrap used in iron and steel production. One group of 1970 figures indicates a large accumulation of junked cars: 4 million abandoned, 14.5 million in dismantlers' inventories, and 1.2 million in scrap processors' inventories. Still, studies show a high potential demand for ferrous auto scrap; improved technology is increasingly available; and auto design changes could considerably speed dismantling and improve scrap quality.

A second possible benefit of increasing automobile useful life is economic efficiency. If one could make a car that could last on the average 20 years, one would have to weigh against its costs those costs involved in making two cars on the current design (10-year useful life). Possible factors to consider would be the following: recycling costs, or, in the absence of recycling, costs of obtaining and processing new material; types of materials used in a more durable design and, perhaps,

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increased assembly costs; the relative size of the additional cost of producing the second 10-year car; relative maintenance and operating costs; and the possible negative economic impacts of regulatory efforts to promote a more durable design, including description of the auto industry's operations, reduction of the annual market for new car purchases affecting ability of low-income people to afford used cars, and slowing of the rate of introduction of new automotive technologies.

Indirect evidence exists that auto accidents are not the primary determinant of the scrapping decision; accident-related scrappage is relatively low. The greater share of cars scrapped comes from the 7- to 11-year-old categories; very few cars are scrapped during the first few years of their lives.

The decision to scrap a car is probably to a large extent an economic choice, influenced by a complex set of factors, including disposable income. The core economic element of the scrapping decision is the owner's comparison of the price of a replacement car with the cost of maintaining or repairing the present one. A government study indicates that many cars are traded in, needing repairs that the owner is unwilling to make.

It is common knowledge that a car's market value drops sharply in the first few years; at the same time, costs of maintenance and repair increase. Clearly, the incentive to scrap grows with time, and one can expect the number of scrappings to grow.

Annual style changes by the auto industry may be cited as one major factor in the precipitous decline in auto market value with age; a decline in psychological value to the consumer via aggressive advertising (psychological obsolescence) is translated into a decline in market value. Similarly, the practices of automobile manufacturing, insurance, parts, and repair industries have significantly inflated auto repair costs. Another factor is a decline in the physical durability of automobiles; current automobiles have been found to be far less resistant to accident damage and other wear than they could be.

Clearly, much more information about the scrapping process is needed to know whether useful life can be and should be increased, what points in the complex scrapping process are most subject to intervention, and what means of intervention are most effective. It is necessary to know the following: the interacting roles that accidents, design and construction, prices and maintenance costs, income, and psychology play in the scrapping decision; how these effects flow from the sturucture and behavior of auto manufacturers and other elements of the auto transport system; and how structure and behavior can be influenced.

Clearly, one cannot rely on the market to induce changes in auto useful life; the lack of improvement (and perhaps decline) of an observed useful life since the 1950s bolsters this conclusion. Fierce competition within

the industry militates against drastic departures from proven and accepted ways, even where such departures would increase industry profits.

Several alternative intervention routes are available. The government could specify the kinds of technology to be employed by manufacturers (as with safety belts). One drawback is the need for a large research and development effort which is probably better conducted privately. Government specification of technology would also remove the incentive of industry to find a better means to do the job.

The government could set standards of performance to be met by whatever technology manufacturers decide to use (as with exhaust-emission standards). The problem of developing general criteria of durability, that can be applied to cars prior to the time of scrapping, arises. It has been noted, however, that just as marine insurers have successfully rated ship seaworthiness, auto insurers can rate car models on the basis of designed-in repairability and actual repair experience.

Another possible measure is a scheme of graduated charges (line emissions charges proposed to deal with air pollution) to attribute the full social cost of a car's lack of durability to its users. Difficulty with this approach arises in attempting to measure the legitimate costs that can be imposed for each auto type.

To the extent that manufacturers now lack the technical knowledge necessary to perceive economic opportunity in producing more durable cars, government research and development assistance could be provided through direct aid or tax relief.

A final measure open to the government is to alter the automobile industry itself: manufacturers, insurance, repair, parts, and other associated industries. Despite the inherent difficulties and complexities, durability is, like other aspects of automobile performance, a product of the nature of the auto industry, and no full exploration of a performance problem is possible unless industry change itself is considered as one of a range of alternative intervention measures.

XX. AUTOMOBILE DURABILITY

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XX. AUTOMOBILE DURABILITY

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Introduction

Amid rising concern about automobile emissions, fuel economy, and safety, another aspect of automobile performance--durability--has received relatively little attention. This paper explores the issue of automobile durability, asking what factors determine its length, why it should or should not be increased, and how an increase might be accomplished, pointing out research needs along the way.

Current Levels of Durability

The physical durability of a car is difficult to isolate from the mix of other factors--including economic and psychological considerations, climate, occurrence of accidents, and so on--that interact to determine the actual amount of time a car is used before being scrapped. Thus, the best, if very rough, indicator of automobile durability is actual useful life.

The common assumption that most American cars last about 10 years conceals a somewhat more complicated pattern of automobile life. The number of cars in use in this country has risen from about 55 million in 1960 to about 85 million in 1973.[1]* During that time, the number of new cars registered each year has risen from about 6.5 million to about 11.5 million.[2] The number of cars scrapped each year from 1960 to 1972 rose from about 4.3 million to 7-8 million.[3] These figures confirm in a rough way the common estimate of a 10-year useful life for automobiles. One would not expect the number of new cars registered in a given year to be immediately reflected in the number of cars scrapped during that year, since there has been a steady yearly increase of people buying cars for the first time and of families acquiring second and third cars.[4] Instead, 10 years after a fleet of new cars was registered, roughly that same number would be scrapped; the new car registration and scrappage data in Table XX-1 exhibit this general pattern.

Of course, a year's fleet of new cars is not scrapped in toto after the tenth year of use; some cars last shorter and some longer periods. Sawyer has calculated, for the years 1946 to 1968, the percent of the original year's fleet still in use during each year of the fleet's life. Figure XX-1 exhibits the average of his data. By the eighth year, a

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*Superscript numbers in this paper refer to the List of References at the end of the paper.

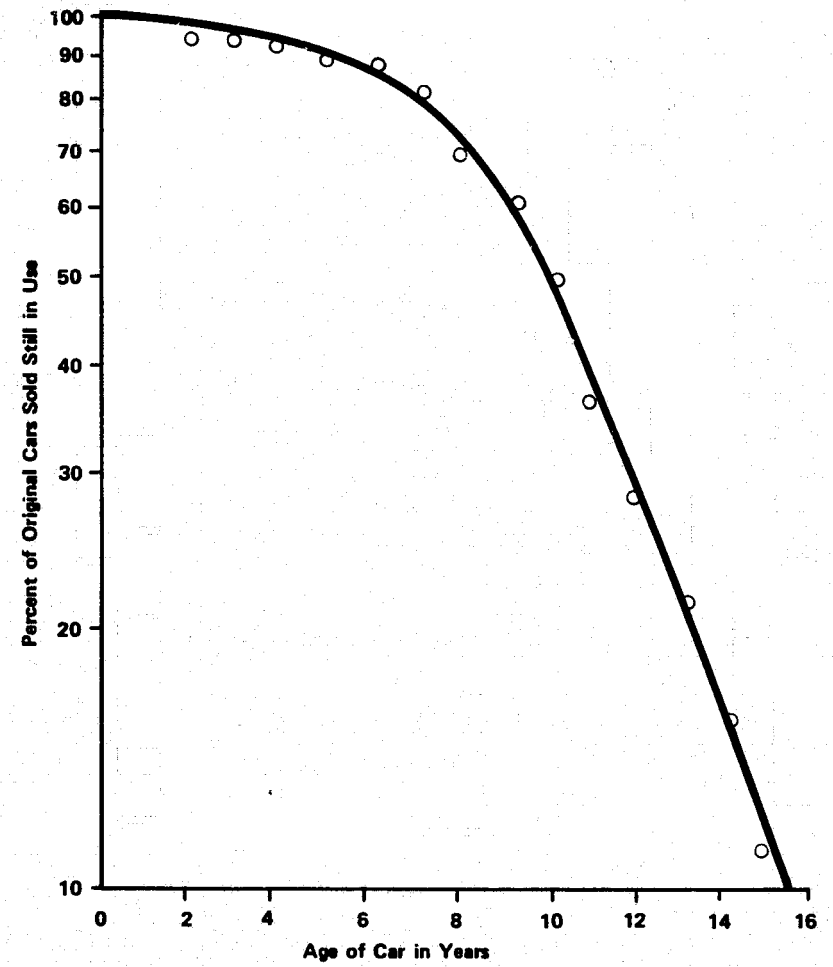
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Table XX-1

CARS REGISTERED AND SCRAPPED

Year	New Cars Registered During Year	Cars Scrapped During Year
1953	5,738,989	
1954	5,535,464	
1955	7,169,908	
1956	5,955,248	
1957	5,982,342	
1958	4,651,002	
1959	6,041,275	
1960	6,576,650	
1961	5,854,747	
1962	6,938,863	
1963	7,556,717	5,319,286
1964	8,065,150	5,704,373
1965	9,313,912	6,173,512
1966	9,008,488	6,957,988
1967	8,357,421	6,226,243
1968	9,403,862	6,348,488
1969	9,527,283	7,460,984
1970	8,459,503	6,021,041
1971	9,963,558	7,058,029
1972	10,608,236	7,987,384
1973	11,477,559	7,193,679

Source: *Ward's 1975 Automotive Yearbook.*



Source: J. W. Sawyer, Jr., *Automotive Scrap Recycling: Processes, Prices, and Prospects*, p. 48 (1974).

Figure XX-1. PERCENT OF CARS IN USE BY AGE

quarter of the fleet is gone. By the tenth year half remains, and by the twelfth year, 30%. After fifteen years, the residual becomes very small. These data and Sawyer's calculation of the probability of a car surviving each successive year (.483 for year 10)[5] also support the 10-year average useful life estimate.

This scrappage pattern is in turn reflected in the age distribution of cars in use each year. During the last decade, roughly 60% to 70% of the cars on the road each year have been 7 or fewer years old,[6] and the average age of cars on the road has held steady at between 5.5 and 6.0 years since 1960.[7]

There is, in addition, some evidence of a decline in useful life of automobiles in the past. White has calculated the number of cars, as a percent of their original fleets, still on the road during the seventh, eighth, and ninth years of their lives, for the years 1955 to 1967. He found that during that period the percentage for 7-year old cars dropped from 92% to 84%, for 8-year old cars from 85% to 74%, and for 9-year old cars from 79% to 56%.[8]

The Desirability of Increasing Useful Life

Several distinct benefits are commonly claimed to flow from an increase in the useful life of automobiles, one of which is resource conservation. If the same bundle of metal and other resources can be made to give 15 instead of 10 years of service before being discarded, the net effect will be a lower rate of depletion of increasingly scarce resources.

Of course, to the extent that this bundle of resources is recycled instead of discarded, the problem of resource waste is mitigated (ignoring the costs and energy use in fabrication), and the useful life of the car becomes irrelevant. From the standpoint of resource use (at least, resources that actually become part of the car), there is no difference between one car that lasts 15 years and two, made of the same materials, that last 7-1/2 years each.

Considerable attention has been paid the problem of recycling scrapped automobiles in the United States. Studies have found that a combination of economic, regulatory, and technological problems has prevented full and prompt recycling of scrapped vehicles. Scrap from automobiles supplies a relatively small percent of the total scrap used in iron and steel production, about 9%,[9] and is of relatively poor quality compared to the bulk of scrap used.[10] The technology required to reduce automobile hulks to usable ferrous scrap has often been either unavailable or quite expensive, although that aspect of the situation is changing.[11] Differences in tax treatment of mining and manufacturing industries and differential freight rates have favored use of newly extracted ore over recycled metals.[12] High transportation costs to central locations and new restrictions on open burning of auto hulks have hindered dismantlers.[13] Legal complications involved in clearing title to abandoned

automobiles and asserting government jurisdiction over cars left on private land have slowed the movement of scrapped automobiles to dismantlers.[14] The result is a situation in which there is no market incentive for last owners of automobiles to turn cars over to dismantlers instead of abandoning them,[15] and little incentive for dismantlers to process all of the cars they do get. This, in turn, has meant a large accumulation of junked cars--4 million abandoned, 14.5 million in dismantlers' inventories, and 1.2 million in scrap processors' inventories, according to one 1970 estimate.[16]

Clearly, for the iron and steel content of cars at least, recycling is far from complete. Still, the studies indicate that potential demand for ferrous auto scrap is high,[17] the technology needed to improve the situation is increasingly available,[18] and design changes in automobiles could considerably speed dismantling and improve scrap quality.[19] A wide range of corrective measures has been discussed,[20] and some estimates are that as much as 80% to 85% of cars scrapped are being processed.[21]

Still, there remains a considerable disparity between the percentage contribution of automobile scrap to total ferrous materials production (about 4%[22]) and the fractions of total U.S. production of steel and iron--19.5% (steel), 17.1% (gray and ductile iron), and 41.7% (malleable iron)--used in automobile manufacture.[23] And, while most of the other metallic elements of cars are recoverable, few dismantlers are able to recapture all of them, and there is little information on how much is actually recovered.[24] Clearly, further information is needed on the recoverability of various elements of automobiles, the possibility for changes in automobile design and processing technology, and the relative values and potential scarcities of the constituent elements of cars before the resource conservation benefits of increasing automobiles' useful life can be evaluated.

A second possible benefit of increasing the useful life of automobiles is economic efficiency. If it were possible, for example, to make a car that would last on the average 20 years, we would then have to weigh against the cost of making that car the costs involved in making two cars on the current design. If there were no recycling of the materials in the first of these two cars, then we would have to include in the cost of the pair several additional factors. The cost of the new materials required to make the second 10-year car would have to reflect the full social cost of obtaining and processing the new materials.[25] A recent article suggested that for every ton of steel made from recycled municipal waste, there is a 74% saving in energy, an 86% decline in air pollution, a 40% saving in water used, a 76% reduction in water pollution, and a decrease in 2.7 tons of the mining wastes dumped near mine sites.[26] Though these figures might be lower for pure automobile scrap, since it is probably more difficult to use than municipal waste (which might, however, include automobile scrap), the figures suggest the kind of added cost that must be accounted for if new materials are used to produce the second 10-year car. In addition, the cost of dumping the first 10-year car must be counted. Entirely aside from the strain this

procedure might put on scarce resources, there is a significant cost associated with letting scrapped cars accumulate at the rate of 7 million per year or more. If the materials in the first 10-year car were recycled, on the other hand, we would have to include in the total cost of the two-car scheme the full social cost of recycling itself[27] and the full social cost of whatever new materials were required in addition to the available recycled elements.

Which way the comparison of the one- and two-car schemes would come out would depend on several factors. Obviously, the cost of producing the first car in each scheme--the 20-year car in one, and the first 10-year car in the other--would have to be considered, and it is likely that it would cost more to make the longer lasting car. How much more is difficult to know given the available information. To some extent, more and more expensive materials would surely be used in the more durable car, and perhaps more complex and painstaking assembly procedures would be required. But it has also been argued forcefully that relatively simple design changes would substantially lower accident repair and insurance costs and, to some extent, nonaccident maintenance costs.[28] Since these costs play a substantial role in deciding when to scrap a car (a point developed more fully below), these design changes would probably have the effect of increasing the useful life of automobiles.

Another factor influencing the comparison of the one- and two-car schemes is the relative size of the additional cost of producing the second 10-year car. One element of this factor is the magnitude of the costs themselves. It would seem that, even if recycling is fairly complete and little new material were required to produce the second car (a situation that does not yet exist), the cost of recycling itself and actually assembling the second car would still be of the same order of magnitude as the cost of producing the first 10-year car. A second element of this factor is the fraction of the cost of producing the second 10-year car that must be weighed against the cost of the one-car scheme. In the example above, it was assumed that a car could be produced that would last exactly twice the useful life of the average existing car, but it may well be that it is possible to extend the life of a car practically by only 6 or 7 years instead of 10. In that case, only a proportionate fraction of the added cost of producing the second 10-year car could be weighed against the cost of the one-car scheme.

A last factor in the comparison is relative maintenance and operating costs. It might be that these would turn out to be the same for the 20-year and two 10-year cars, but several differences seem possible. The same design changes that might have the effect of lengthening useful life in the manner described above would do so by lowering repair costs. Cars made more durable in this way would probably incur less accident damage, require cheaper repairs where repairs were necessary, and be relatively simpler to repair; and all this, in turn, might lower insurance premiums.[29]

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Here again, considerable research is necessary before an accurate comparison of the relative costs of a single, long-lived car and several shorter-lived cars is possible. We can conjecture from the rough outlines of the comparison that it is well worth making. There may be substantial economic benefits from a longer-lived car, but more must be known about the potential for, and cost of, a more durable car before much more can be said. Since projections of the cost and useful life of a more durable car are necessarily somewhat conjectural, it might be particularly useful to examine the handful of existing cars--some foreign models and a few domestic ones--that have, by design or accident, lasted longer than most other cars. Another useful, but necessarily limited, inquiry might be made into the useful life of trucks, whose average age has grown to the vicinity of 7 to 8 years while that of cars has held steady near 5.5 to 6 years.[30]

Finally, there might also be clear disadvantages associated with a more durable car, even if considerations of resource conservation and efficiency work out in favor of a longer useful life. Most of these are probably transitional, but no less serious for that. For example, there is the possibility that regulatory efforts to force American producers to make longer lasting cars would disrupt the industry enough to have undesirable economic consequences. It would certainly reduce the annual market for new car purchases. Or, some claim that introduction of more durable cars would so alter the existing pattern of new and used car purchasing as to erase a claimed subsidization by new car buyers (who absorb very large depreciation losses during the first few years of a car's life) of used car purchases, thus making cars available to more low-income people. These and similar considerations must be taken into account in weighing the desirability of producing longer lasting cars. Finally, there is the potential problem that longer-lived automobiles would slow the rate of introduction of future new automotive technologies.

The Determinants of Useful Life

Much more than simple physical durability is at work in the decision to scrap a car; a complex set of factors is involved. There has apparently been relatively little investigation of the scrapping process, but one must know considerably more about it in order to determine the possibility and desirability of lengthening the useful life of automobiles.

Accidents. It is sometimes claimed, usually by automobile manufacturers or someone speaking for them, that cars are often scrapped not because they wear out but because they are rendered useless by accidents.[31] If this is true, it might be claimed as a strong argument against increasing the physical durability of cars, since many accidents will involve relatively new cars, and these cars' potential for a long life will be useless.

Direct information on the fraction of yearly scrappage that is due to accidents is not immediately available, but some indirect evidence appears to argue against this interpretation. A 1967 Interior Department study of automobile disposal indicated that wreckers got 38% of their cars from individuals, 26% from auto and truck dealers, 21% from insurance companies, 12% from state and local government, and 3% from other sources.[32] If it is assumed that most cars that have been "totaled" in accidents come from insurance companies or state and local governments, the share of accident-caused scrappages is on the order of 30%. Testimony before a Senate committee has also indicated that a very small fraction of all the claims paid by insurance companies for auto property damage involved replacing the car--about 4%.[33] Other testimony indicated that the percent of all claims that were for totaled cars hovered around 1% to 2% for the first 5 years of car life and then rose steadily to about 12% by the eighth year.[34] These figures do not, of course, fix the absolute magnitude of accident-related scrappages, but there is some evidence that the figure is relatively low. Along with other data, moreover, they belie the notion that accidents are the primary determinant of the scrapping decision. Table XX-2 gives profiles, for several recent years, of the numbers of cars of various ages that were scrapped during the year. These numbers, along with the data in the section above on current levels of automobile durability, indicate that the great share of cars scrapped are from 7 to 11 years old, and that very few cars are scrapped during the first few years of their lives. If the simple occurrence of collisions were the prime determinant of useful life, one could expect the age distribution of cars scrapped in a year to be somewhat more even. To some extent, of course, it is probably true that older cars are more accident-prone, but even that would not seem to fully explain the tendency of scrappings to cluster around the ninth and tenth years. Other factors are certainly at work, and it seems more useful to treat accident-induced scrappings as a subset of a different, more general mechanism.

Prices and Repair Costs. The decision to scrap a car is probably to a large extent an economic choice, influenced by a complex set of factors, one of which is disposable income. There is no direct evidence of the effect this factor has on the scrapping decision, but a 1967 Interior Department study provides a useful insight. A survey of the inventory of junk cars in urban and rural areas showed that in both, about half of the total inventory was between 8 and 12 years old, but the percent more than 12 years of age in rural areas was twice that in urban areas, and the percent less than 8 years of age in urban areas was twice that in rural areas.[35] If it is assumed that incomes are generally lower in rural areas, this difference in inventory age might be taken to demonstrate that useful life is stretched out longer where incomes are lower--a conclusion the study suggested. (Of course the difference might also be due to the greater difficulty of getting cars scrapped in rural areas to centrally located processors.)

Table XX-2

AGES OF CARS SCRAPPED DURING CERTAIN YEARS

1965	
Age (years)	Number Scrapped
2	33
3	3
4	71
5	132
6	182
7	331
8	597
9	702
10	862
11	604
12	648
13	321
14	357
15	320

1968	
Age (years)	Number Scrapped
2	23
3	9
4	1
5	124
6	218
7	369
8	659
9	882
10	650
11	749
12	642
13	593
14	306
15	266

1971	
Age (years)	Number Scrapped
2	19
3	14
4	106
5	225
6	335
7	465
8	644
9	784
10	742
11	741
12	509
13	236
14	266
15	214

1974	
Age (years)	Number Scrapped
2	11
3	93
4	119
5	166
6	360
7	496
8	802
9	1005
10	987
11	874
12	657
13	367
14	285
15	157

With income accounted for, though, it seems likely that the core of the economic element of the scrapping decision is the comparison of the price of a replacement car with the cost of maintaining or repairing the present one. Cars wear and parts break; accidents, small and large, occur. The owner is faced with the choice whether to fix the car or get rid of it and get another. If the cost of repairs is high enough (as with a serious collision involving a relatively new car), or if the cost of replacing the car is high and the value of the unrepaired car is low (as with a relatively old car with several lingering ailments), the owner will get rid of the car by scrapping it since it will bring so little on the market. (The scrap value of cars, still quite low, would appear to play little role in the scrapping decision.) Again, there is little information about this aspect of the scrapping decision, but one government study of the operating costs of cars indicates that many cars are traded in, usually to dealers, because they need repairs that the owner is not willing to make.[36] This implies that the same mechanism is at work when the car's last owner decides to scrap it.

The combined trends of car prices and repair costs over a vehicle's life probably do much to explain the shape of the age distribution of cars scrapped in a given year. It is common knowledge that the market value of a car drops sharply during the first few years of its life.[37] At the same time, as the car gets older, the cost of maintenance and repair increases.[38] As prices fall and costs increase, the incentive to scrap grows, and one can expect the number of scrappings to grow. After some number of years of heavy scrapping, relatively few cars of a given vintage are left on the road, and even though the incentive to scrap is still strong, the number of cars has declined, and consequently, the number of scrappings declines. This is the pattern actual scrappage figures exhibit.

These price and repair cost trends are rooted in the structure and behavior of the various elements of the automobile industry. Many observers of the industry feel that the major cause of the precipitous decline in the value of a car as it grows older is the industry's firmly entrenched practice of offering a wide variety of slightly differing styles of automobiles and changing these styles somewhat each year. This annual style change, coupled with aggressive advertising, it is claimed, creates a psychological pressure on new car buyers to trade in their cars after a few years for new ones, and a similar pressure on others to become new car buyers in order to keep pace with current styles. As the psychological value of a car drops in the eyes of the consumer, so does its market value; and the result, it is claimed, is that the industry sells more and more expensive cars.[39] The practice of annual style change was introduced into the automobile industry in the 1920s as a response to the saturation of the first-car market and the competition the new crop of used cars began to offer to new car sales. Style changes were seen as a way to create enough dissatisfaction to get new car owners to trade in their old models, but not so much dissatisfaction that the old models had no remaining market value, for that would discourage trade-ins.[40] Whether the compulsion to

continue the practice is inherent in the industry[41] or the result of the economic advantages the practice is claimed to offer--including inflated prices, greater sales, excuse from the need to make nonstylistic design changes, and barriers to entry of competing firms[42]--is disputed. But annual style change and its effects on automobile prices, are clearly basic elements of the industry, linked inextricably to the industry's shape and process.

The same is true of rising repair costs. Lengthy hearings before the Subcommittee on Antitrust and Monopoly of the Senate Judiciary Committee in 1969 revealed a pattern of abuse in the automobile manufacturing, insurance, parts, and repair industries that had significantly inflated repair costs.[43] Here the blame is shared by others, but an ample portion fell on the manufacturers themselves. Witnesses claimed that a series of manufacturers' activities--including procedures designed to guarantee a large share of the lucrative parts aftermarket, publication of "flat rate" repair manuals that discourage competition and encourage replacement instead of rebuilding of parts, and failure to design cars with accident resistance and easy repairability in mind--had contributed to the high cost of repairs.

Physical Durability. If some mixture of accidents and the economic calculus of income, car prices, repair costs, and other factors accounts for scrapping decisions, then what role is left to actual physical durability--that is to say that a car has simply "worn out"? Is it not true that old cars never just fade away, but rather that the invisible hand of fate or the market makes the cars useless to us?

In one sense, the answer is yes. Putting aside psychological obsolescence (see below), the scrapping decision seems likely always to be essentially an economic one. Something goes wrong with the car in one way or another; the owner adds up the costs of his options and either keeps the car or gets rid of it. Thus, it would be possible, if repair parts and labor were cheap and readily available, to continue fixing a car indefinitely, replacing an engine here, an axle there, a fender here, and so on. The car might eventually contain none of its original parts, but it would never simply "wear out." This process of replacement would end only when economic considerations made it irrational. As things stand now, this usually happens around the tenth year of a car's life or soon after.

But this view of the scrapping process ignores the fact that the time in a car's life when the economic calculus dictates that it be junked is determined in part by the physical durability of the car. If two cars of the same age deteriorate in market value at the same rate and are subject to the same set of repair costs, but the first rusts out or develops serious engine trouble two years sooner, the second car will surely last longer, even if the final scrapping decision for both cars involves the same kind of economic factors. This will be true as much of scrappings induced by accidents as it is of other kinds of wear on

a car. Cars that, by virtue of their design and construction, are less subject to deterioration of any type will not as soon become uneconomical to keep running.[45] This mechanism might also interact with price to make a car last longer. If one kind of car is perceived to be more physically durable, it might well hold its market value in its later years better than a less durable model, in spite of the depressant effects of psychological obsolescence, and this will further delay the time when scrapping becomes economically necessary.

Evidence of the role of physical durability is slim. White has attempted to isolate this factor from others at work in the scrapping process by statistical methods and has found a decline in actual useful life that may be due to a decrease in physical durability.[46] And testimony at the 1969 repair industry hearings indicated that current automobiles are far less resistant to accident damage and other wear than they could be.[47]

Psychological Durability. It is frequently claimed that American automobile producers, faced each year with the need to sell new cars to a pool of buyers most of whom already have cars, resort to a practice of frequent style changes and persistent advertising designed to induce people to part with their old cars while there is still life in them.[48] Implicit in these claims is the idea that car owners are induced in this way to scrap their vehicles before the time when all the other factors in the scrapping decision would have dictated getting rid of the car. Psychological obsolescence shortens actual useful life.

Viewed one way, this argument seems incorrect. It can be argued that the target of the policy of annual style change and the associated advertising is the pool of new car buyers, but most of these people probably never have anything to do with scrapping a car. The cars they trade in are resold one or more times.[49] A different group of people, arguably much less susceptible to advertising and style change, decides when cars will be junked.

This conclusion seems to follow from the nature of the problem. One limit on the number of cars the manufacturers can sell in a year is set by the interaction of the average useful life of cars with the stock of cars people want to maintain to serve their driving needs. In a simple example, if there are 24 people each needing a car in a given year and cars last for 8 years, then 3 cars can be sold each year. Eight years after the first year's sale of 3 cars, those 3 buyers will discard their used-up cars and buy 3 more. The same thing will happen 8 years after the second year's sale, and 8 years after the third and fourth years and so on. A situation will be set up in which, each year, 3 people who bought cars 8 years ago will come back for 3 new cars.

Introducing annual style change and new car trade-in into this simple example does not change the basic relationship between the stock of cars, average durability, and number of cars sold per year. Instead of 8 groups of 3 car owners, each of which holds onto its cars for all 8

years of their lives, there will now be a group of new car buyers who trade their cars in at some point short of the end of the cars' useful lives and another group of owners who take over the used cars until they are ready to be discarded. If the time the new car buyers hang on to their cars is 2 years, then a situation will arise in which there are 2 groups of 3 new car buyers each and 6 groups of 3 used car owners each. The manufacturers will sell 3 new cars to one or the other of the new car buying groups each year. For each of the first 6 years, the 3 used cars per year generated by this process will be taken over by one of the used-car-owning groups. By the seventh year the first of these groups will be ready for a new set of used cars, and so with the following years. Thus, the manufacturers will still sell 3 cars per year; the only difference is that they now sell more frequently to a smaller segment of the car-owning population. And if the manufacturers manage to induce new car buyers to hold their cars a shorter time before buying again, or induce more people to buy new cars, it will be seen that the stock of cars people are willing to hold and the average durability of those cars again dictate that 3 cars will be sold each year. Only the number of people in the new car-buying group varies.

The real world, of course, is much more complex than this. Cars are traded in more than once, they last different periods of time, the stock held varies each year, and so on. But it would seem that the basic limitation imposed on the number of cars sold per year by the stock held and by average durability still holds, if in a rough way. After some point, the market is saturated with new and used cars, and no amount of additional advertising will increase sales.

Does this mean that psychological obsolescence plays no role in the scrapping process? Probably not, for several reasons. One is the depressant effect that annual style change has on the prices of used cars, discussed above. Along with hastening the time when it becomes uneconomical to keep a car, this price effect may well enlarge the stock of cars people are willing to hold and thus increase the number of cars that can be sold in a given year. If prices of used cars are very low toward the end of their lives, one observer suggests, it is more likely that more low-income people will be able to own them, thus increasing the stock of cars held.[50]

Psychological obsolescence may also extend to used, as well as new, car owners and induce them to get rid of their cars "prematurely." There is little evidence on this point, however.

Finally, annual style change may amplify other factors in the scrapping decision. As the number and complexity of available models increase, repair costs increase,[51] and to some extent styling changes come at the expense of design changes intended to increase safety and physical durability.[52]

Research Needs. Clearly, much more information about the scrapping process is necessary in order to know whether useful life can be and should be increased, what points in the complex scrapping process are most subject to intervention, and what means of intervention will be most effective. It is necessary to know the following: the interacting roles that accidents, design and construction, prices and maintenance costs, income, and psychology play in the scrapping decision; how these effects flow from the structure and behavior of the automobile manufacturers and other elements of the automotive transportation system; and how structure and behavior can be influenced.

Methods of Change

The means of increasing the useful life of cars, assuming that is both desirable and technically possible, is a complex and necessarily speculative subject, and only a few comments are made here.

It seems clear that one cannot rely on the market to induce change. The simple fact that the observed useful life of American cars has not increased (and has perhaps decreased) since the beginning of the 1950s points to this conclusion. It might be argued that no one has seriously tried to market a more durable car, and thus, the market has never been tested. This might be so because there has never been a genuine consumer preference for a longer lasting car, but it seems more likely that there has never been a clearly defined opportunity (in the form of a domestically built car at least) for consumers to express such a preference. Nor, without some kind of intervention, is there likely to be such an opportunity. The discussion above indicated several ways in which the determinants of actual useful life are rooted in arrangements that the automobile industry finds profitable and is not likely to change. The yearly competition for shares of the new car market is fierce, and there is considerable incentive to avoid the risk of drastic departures from proven and accepted ways, even where such departure would increase industry profits.[53]

What means of intervention are available, then? A range of measures is possible in any public effort to alter some aspect of automobile performance. One set, already is use for the automobile safety and air pollution problem , has the government either specifying certain kinds of technology the manufacturers must put in their products or setting standards of performance that must be met by whatever technology the manufacturers decide to use. Requirements for use of certain kinds of signal lights or safety belts and exhaust emission standards are examples of the two types of measures. Both approaches have limitations. Beyond a certain level of complexity of the problem to be solved, outright government specification of technology would require a large research effort that could probably be better conducted privately. Once the government decides on a specific device, the incentive to find better means of doing the same job disappears. The standard setting approach, on the other hand, encounters the problem of finding general criteria

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of durability that can be applied to cars before the time they are scrapped. Unlike exhaust emissions, durability is not something that can be physically measured as a characteristic of the car's daily performance; the real measure of any car's longevity can only be taken on the last day of its useful life. Still, it seems possible to arrive at some kind of durability standard. Witnesses at the 1969 automobile repair industry hearings noted that marine insurers have long rated the seaworthiness of ships and that it would be possible for automobile insurers to rate car models on the basis of their designed-in repairability and their actual repair experience.[54]

Another possible measure is a scheme of graduated charges, like the emissions charges sometimes proposed to deal with air pollution, designed to attribute the full social cost of a car's lack of durability to its users. Though it has the virtue of efficiency, such a scheme might have more than the usual difficulty associated with such methods in measuring the cost that can legitimately be imposed on each type of automobile.

Beyond schemes of charges lie other measures a government can employ to alter the demand manufacturers face. Government might, for example, reduce speed limits as a means of reducing engine size or have its agencies purchase only certain types of vehicles. Short of the last example, though (which probably has little effect, since government operates a very small fraction of all cars registered[55]), there seem to be few measures of this sort that would work for the durability problem.

Another available measure is government provision of research and development assistance, in the form of either direct aid or tax relief to enhance private R&D efforts, or actual performance of research by government employees. To the extent that the manufacturers now lack the technical knowledge necessary to perceive economic opportunity in producing more durable cars, government-sponsored R&D would surely enhance the operation of the market. Under any circumstances, government research would certainly smooth the transition to a new way of doing things and help guarantee that the measures the government chooses are the most effective and sensible ones.

A last measure open to the government is to alter the automobile industry itself. This encompasses a wide range of possible actions taken to regulate not just the manufacturers, but the insurance, repair, parts, and other associated industries. This is obviously a difficult and complex subject, but durability, like other aspects of automobile performance, is very much a product of the nature of the automobile industry, and no full exploration of a performance problem is possible unless change in the industry itself is one of a range of intervention measures considered.

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XXI. INTERCITY TECHNOLOGY AND ORGANIZATION: A PROPOSAL

by

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ABSTRACT

Though many of the accompanying papers would like to see attempts at organizational innovation in the political and economic scene, it would seem that government research agencies should continue to devote their resources and energies to technological innovations, an area of demonstrated suceess. This paper considers possible directions of technological development within the different modes of intercity transportation (ICT), subject to tests of political acceptability.

Though the organizational concepts of ICT need development, technological innovation possibilities are available. Of those innovations suggested, the complementary package of highway automation, congestion processing, and expedited bus service seems most appealing for federal investigation and possible support; their complementary nature guarantees a broad political base, and is highly suitable to the incremental development approach. These innovations would involve a substantial study of electronics control systems, which is generally within government research agency experience, and it should have broad political support.

Air Traffic Control (ATC) also has a broad political base and allows incremental development. ATC needs improved systems analyses and hardware. A major airport systems problem is the "break in gauge" between the small highway unit and the large air unit.

Rail terminals do not have a broad political base. Apart from those of ConRail in the Northeast, they are jealously private and are unlikely to welcome outside suggestions. Thus, publically sponsored innovations at terminals would be more productive at airports. Probabilities are that there will be massive private sector involvement in rail, and rail rehabilitation will not be innovative. Basic research and technology development should, then, explore possible rail innovations which could be applied during receptive periods.

In sum, highway transportation holds out the best prospects for technological innovation, followed in decreasing order of success by air traffic control and air terminals. Rail terminal and other rail-related innovations have the least likelihood of development and implementation, due to failure to meet tests of political acceptability.

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XXI. INTERCITY TECHNOLOGY AND ORGANIZATION: A PROPOSAL

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Introduction

This paper considers possible directions of technological development within the different modes of intercity transportation (ICT), subject to tests of political acceptability.

Most of the innovative issues seen in other papers are organizational rather than technological. And they are organizational at the political or economic level. Public agencies have shown the ability to innovate technologically, certainly with the requisite hardware, and with the organizational and systematic skills needed to operate that hardware. It is less clear that these agencies possess the skills required to make innovations on the political or economic scene, where methodology is already established and powerful interests are ready to defend the *status quo*. It is obvious that many of the accompanying papers would like to see a countervailing force develop. Public agencies need to ask whether they should devote their resources and energies to the development of such a force.

A decision to move in that direction would be innovative, but it may well be that government should continue in those directions where demonstrated success is apparent.

The latter choice would mean emphasizing innovations that are technological, or those that involve the organization of technology or methodology. If that choice is accepted, we can then sift through the innovations suggested by the project's issue papers for those that meet the tests of political acceptability posited by Garrison and Jones, the two most important of which are the existence of a broad political base and susceptibility to incrementalism. A broad political base means that the innovations have the potential of bringing benefits to most, if not all, Congressional districts, and that funds be spent locally for the necessary hardware and/or infrastructure construction. Incrementalism means that the innovation is susceptible to piecemeal development. One-shot deals are often acceptable, but an innovation which promises continuing and increasing benefits, together with future injections of spending, is preferred.

To begin with, there are organizational concepts of ICT to be developed. Garrison points out, in his conclusion, that there is no overall system. Carter points out the internodal nature of line-haul transport. The nodes are termini, and there is general agreement that there is room for innovations at the terminals. Conceptualization would seem an early need, and the theory of long-distance transportation flows needs

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development. Transport prices are not simple functions of distance, and so Weberian tonmile models and the civil engineers' gravity models do not explain very satisfactorily the nature of ICT. The undirectional movement of freight, and the increasing specialization of vehicles for that movement compound the problem.

Highway Transportation

It does not follow, however, that technological innovation must await the development of some theory of ICT. The technology of highway transportation is important, popular, visible, and ubiquitous, and it accounts for the majority of transportation spending. Some innovations there would clearly be effective, would require no additional conceptual development, and would be helpful to the innovating agencies.

Of all the innovations suggested, the complementary package of highway automation, congestion pricing, and expedited bus service seems the most appealing for federal investigation and possible support. It involves a substantial study of electronic control systems, generally within the agencies' experience, and it should have broad political support. Moreover, it is something which is not yet being done; hence, there is no established organization to oppose the innovations.

Garrison has suggested highway automation and has also mentioned congestion pricing for urban areas. And Jones has suggested that improvements to bus transportation would meet most political tests. It would seem that those three innovations could be made complementary.

A pattern something like this could be foreseen: On the Interstate system one lane (presumably the center) could be automated. Automation means that properly equipped vehicles would be controlled from sensors in the pavement. Vehicle speed, direction, and clearances would be automated and the driver relieved of effort and strain. Automation may be applied incrementally to additional lanes, as required by traffic and/or political needs.

An automated control system could be made compatible with a system of congestion pricing. An additional toll could be collected for the use of the automated lane (the fast lane under congested conditions) and that toll could be varied with the time of day. If the purpose of congestion pricing is to relieve the congestion, then pricing must be in accordance with a predetermined price schedule, so that users can plan when to use the highway. Quite a few years of price experimentation could be expected before the optimum traffic pattern could be made to develop. (A pricing system in dollars is not requisite. If the money price system is not considered an appropriate method to pay for contributing to congestion, equality among income groups could be achieved by issuing congestion ration coupons to all drivers.)

Notice that the three complementary items--the automation of long-distance highway traffic, variable pricing in congested areas, and preferential traffic treatment for buses--mean that a single electronic system should stand on a broad political base. The long-distance traveler should be pleased that his attention is no longer demanded for long time periods and that his trip is safer. Truck and bus operators should feel the same way. In urban areas, many commuters would like to be automated and to avoid the strain and dangers of traffic congestion both before and after work. The urban bus rider, and especially the bus commuter, should be another supporter of the system. In short, political support could come from long-distance highway users, commuters by car, and commuters by bus, a politically invincible group.

Highway automation and congestion pricing are highly suitable to the incremental approach. Development can begin on suburban sections of the Interstate system and can be gradually extended over the whole system, and beyond.

Moreover, while a substantial investment is required (to be spent in most Congressional districts), the system shows promise of producing substantial revenues. Possibly it would be self-liquidating. If so, it could be financed on the money markets.

Highway automation is only one direction in which we might move toward greater highway safety. Work could be done on the relations between automotive weight, size, and safety. With proper accounting for fatalities and serious injuries, an increase in safety may well be congruent with a reduction in cost. The present emphasis on fuel economy might show itself to be a misallocation of innovative resources.

Air Traffic Control

While the highway transportation field offers the best prospects for innovation, there are other possibilities. Probably the second field in terms of potential for innovation is Air Traffic Control (ATC). There is general agreement that ATC needs improvement. ATC meets the political tests; innovation can be incremental, and it has an impact in all Congressional districts; air transport is, however, less popular than highway transport, and improvement spending there may be seen as benefitting business and the well-to-do. However, on intrastate flights, where fares are not held at the interstate levels imposed by the CAB, passengers appear to be a pretty fair cross section of the community.

Recent accidents and near-misses imply the ATC has a systems problem. Controllers and pilots do not appear to have the same expectations for the meaning of the rules. All are working under difficult conditions and tremendous pressure. The cessation of growth in air traffic and the introduction of widebody jets has reduced the pressure to improve

the ATC system, but the need remains for both systems analysis and hardware to permit the system to give a more positive performance.

Terminals

A third place where innovations may successfully be attempted is at terminals. Airports represent the interface between the line-haul air movement and the distributive highway movement. That interchange is handled with some difficulty, particularly at the highway end. There is a systems problem with the "break in gauge" between the small highway unit and the large air unit, and with the loading space available for the highway vehicles.

Railroad terminals also present a systems problem. That is probably less true in the large yards where line-haul trains are broken up and assembled (Roseville, Colton, Barstow, North Platte) than in the smaller yards where movement is irregular. These smaller yards may not have humps, flat switching may be required, and orders for empty cars may offer little lead time for planning. Yard operations are conducted under the archaic AAR Car Service Rules, developed long before computers provided a central inventory of cars and their locations. A need exists for systems analysis and probably for computer programming. There is probably little need for the development of hardware; requisite computers are probably available on the shelf.

Compared to airports, rail yards lack political appeal. They are not very visible; freight doesn't vote. Their noise pollution is less pervasive than that of airports. Moreover, while airports are always in the public sector, only in the northeast are railroads now passing into public control. Elsewhere, they represent rather jealously guarded private property. Operating rules are not uniform among private railway companies; resistance to change is strong. The interference of an outside agency is unlikely to be welcomed.

Thus, with present organization and differentiation between public and private sector ownerships, federally sponsored innovation in terminals would more productively be devoted to airports. While rail yards and airports are both terminals, the methods of operation are so different that there may be little cross-fertilization in the analysis in any case. In the unlikely event that significant changes in rail organization occur, as suggested in the Carter paper, then rail terminal analysis could be undertaken as part of a broader systems study of railways.

Rail-related Innovations

The remaining innovative suggestions are rail-related; their effectiveness and the welcome accorded to them will depend in part on the changes in rail organization which develop. As already indicated, innovations in the rail field may not be very visible, although the public sector

will become increasingly involved. Early 1976 will establish ConRail in the public sector; then planning for innovation may become acceptable and spread to that part of the industry remaining in the private sector, although the impact will not be immediate. While the political path by which it will be reached and its organizational form are not clear yet, the probabilities are large, of the order of 90%, that there will be public sector involvement and massive rehabilitation of railways by the end of the century. The probabilities are also high, perhaps 75%, that that rehabilitation will be repetitive rather than innovative.

The federal government might reasonably foresee the upcoming public sector involvement in railways and develop a shelf of innovations when the organization and management attitudes become more receptive.

There is general agreement that large numbers of small technical items in the railway industry require innovative attention. These items do not depend necessarily on public sector dominance in the industry nor on massive organizational changes. They could be worked out cooperatively with the railway supply industry and then marketed through the usual industry channels.

These small technical items are dominated by track. Nationwide, maintenance has deteriorated and standards have been reduced. Cars are heavier, track is rougher, and train speeds are slower than was true a generation ago. Slower trains mean less productive labor and capital. The rehabilitation of track to former standards or to the standards prevailing in other industrial nations could be done without innovation, merely using labor, materials, and existing methodology. Innovation would consist of developing track which would be less expensive to maintain: a concrete roadbed, for example. That should be a politically welcome substitute for declining highway construction.

Train-handling equipment is another item. Couplers operate automatically under certain conditions of speed and alignment, but air brakes must be connected manually. The present air-braking system was invented long ago and does not operate uniformly and simultaneously through the train. Transit cars have couplers that grip automatically at proper speeds and alignments, and carry the controls as well. There is room for an innovative braking system that is compatible with automatic coupling and does not require the making of connections manually. To meet the requirement of incrementalism, the new system should probably be compatible with the present system.

Innovations in the direction of safer and more easily maintained equipment are also generally accepted as needed. Leaking or spilled cargo may cause fires and/or explosions. Even when two men are on lookout in the caboose, the length of a 100-car train may not always be visible.

Finally, there are many systems and communications innovations which could be made if the sort of organizational changes suggested in the Carter paper came about, that is, if the railways abandoned their 19th

Century form of organization and became public highways in the organizational fashion of 20th Century technologies. But there is no popular clamor for access to the railways. Why should there be, with access to the highways available to the small carrier? There is strong institutional opposition to the multiple use of rail lines within the AAR. If there were multiple use of rail lines, the monopoly issue would disappear, and the regulatory agencies would lose their basic *raison d'être*. Thus, the probability that the Carter proposal would come about is small, hardly 5%.

The large probability is that public sector involvement in the railway industry will follow the pattern of other countries. Governments took over when railways were no longer profitable for the private sector. In most countries, however, the takeover occurred before the 20th Century alternatives to rail transport were fully developed. Here and now, there can hardly be the popular feeling for the necessity of the rail technology which prevailed at the beginning of the century; still, support or acquisition of railways by the public sector will be a step for preservation--hence, it will be conservative.

The rail constituency is not large, maybe 750,000 employees, and it would be much larger if the railways were opened to public use. There is not likely to be great popular support for the preservation and conservation of the 19th Century monopolies with only a small constituency; and thus, as public sector involvement in the rail industry becomes deeper, one can expect further shrinkage. Bruck's prediction that "long haul commodity movement would be handled by a lean railroad system or by water carriers . . ." could be assigned a probability of perhaps two-thirds.

The railway industry is greatly in need of innovation, but the political and economic situation would not appear to be one in which outside contributions might be welcomed. But they have at least cosmetic effect, and the rail field should not be written off entirely.

In sum, highway transportation holds out the best prospects for technological innovation (e.g., highway automation, congestion pricing, plus expedited bus service) followed in decreasing order of success by air traffic control and airport terminals. Rail terminal and other rail-related innovations face the least likelihood of development and implementation, because of their failure to meet tests of political acceptability.

XXII. TRENDS IN FREIGHT TRANSPORTATION: 1975 to 2000

by

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ABSTRACT

Transportation of freight in the year 2000 will not be very different from today. The next 25 years will be evolutionary.

Volumes of freight will increase, but substantially less than often predicted. Lengths of hauls will shift; some products and commodities will move shorter average distances; others longer ones. Population growth will continue. Other characteristics affecting freight demand are less predictable. Standards of living may well decline. Income redistribution between groups will probably continue. Spatial arrangements of communities will change, as will product characteristics. These and other factors will, of course, increase the quantities of some types of freight and decrease others.

Significant increases of coal movements will hinge on the rate of increase of electric power consumption and, more generally, on the relative importance of nuclear, coal, and solar fuels. Power plants, however, can now be located near coal deposits, because of the improving technology of long-distance power transmission and because institutional restraints on power plant siting may change.

Petroleum movements will change somewhat. Smaller and new-technology cars will burn less gasoline. Alaskan oil will cause redistribution of some flows from fields to markets. Long-distance moves will continue to be by pipelines, tankers, and barges.

Transportation characteristics of construction materials (e.g., lumber, cement, and steel) should not change too much. Many manufactured products will change in size, weight, quantity, and distance to be moved. The highway-transport distribution system will continue to predominate.

Freight transport technology will not be significantly different from today. The past 25 years witnessed most of the innovations (e.g., the Interstate Highway System, supertankers, containerization of break-bulk shipping, and coal-slurry pipelines), and there are no pressing needs for improvements.

The motor truck has been, and will continue to be, the almost universal freight carrier. The new-construction era of highways is, however, over. Trucks may change some, due to regulatory changes rather than technological ones. Motor carrier operators want increases in truck dimensions and weights, "triple-bottoms," and turbine engines. Containers and trailers on flat cars will continue to develop.

Evolutionary refinements of railroad technology will occur along with operational and institutional changes. Track, bridge, and tunnel technology will not change much. Large-scale rail electrifications depend on removal of financial and institutional barriers.

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Air freight will continue to expand in weight, volume, value, and revenue. Whether it will be profitable to carriers is less predictable.

Whether a market exists for new airplanes for all-cargo or mixed cargo-passenger services is a major issue. New, more efficient airfoils, quieter engines, better fuel efficiency, and other innovations make the concept of designing and building new aircraft attractive; on the other hand, the advantages of the newer planes over large fleets of existing ones are marginal, compared with the risks of large new capital investments in an industry with low profitability. Aircraft manufacturing in the next 25 years may possibly concentrate on replacing worn-out equipment, providing maintenance and upgrading parts, and providing for some growth, but not offering a product that makes all existing equipment obsolete.

Waterborne transport service technology is well advanced and requires no significant improvements. For deep-draft vessels, increased speed means greater fuel consumption and, thus, higher energy costs. Automation and advanced propulsion machinery have reduced crew sizes substantially. There is a glut of ships of all types on the high seas. And, ships have become enormously expensive to build, buy, and operate.

Inland or shallow-draft water carriers have well-established equipment and operating patterns. Since the government has assumed the cost of building and maintaining the waterways, the only cost of providing inland waterway transportation is the vessel operating cost, which is quite low for bulk shippers. In effect, inland waterways make possible private and contract carriage of bulk commodities which is not practical and cost-effective by rail or by highway.

Oil and gas pipline technology is evolutionary. Solids pipelines are at earlier stages of development. A major problem is not technical but rather one of water supply. Wyoming officials objected, for example, not to the mining of coal, but to the export of water in a proposed coal-slurry pipeline.

In the next 25 years, the ownership patterns of U.S. railroad facilities and enterprises will change significantly and will fundamentally affect operations. The total freight transportation system will continue to have relatively low profitability. Direct governmental ownership and operation will increase well beyond today's significant levels, particularly for railroads, but to some extent for each of the other modes. Private enterprise will continue to dominate in equipment and operations. Refinements of technology and operations will continue, motivated by safety and environmental considerations and by compelling needs to reduce costs and to increase efficiencies.

Energy price, availability, and possible rationing problems will inhibit major changes in characteristics and technology of freight transport services. For example, development and production of passenger-oriented, high-performance aircraft like vertical/short takeoff and landing

aircraft (V/STOL) and supersonic transports (SSTs), high-speed ground transport like tracked air cushion vehicles (TACVs) and magnetic levitation vehicles (MAGLEVs), and certain freight technologies, all of which have high energy consumption, will be slowed or stopped. Still, energy costs are only a small part of total operating costs. For example, doubling or even tripling of fuel prices will increase total costs of operating freight transport modes by only 10% to 20%.

Some shifts in market shares between modes may be very significant, and range from lucrative to fatal for individual carriers, but they do not presage fundamental shifts in transport technology or services.

Institutional changes will permit some rationalization of the railroad network, free all modes from some current regulatory restrictions, and make more price and service competition possible. Operating changes offer major opportunities for innovation, especially for the rail mode (e.g., dynamic real-time scheduling of freight cars and trains). Work rule changes will yield higher productivity. Marketing changes, particularly orienting transport services to fit into total customer logistics systems, are probably the prime opportunity for continuing innovation.

In short, freight transportation in the year 2000 will not be all that different from today. In service, quality, price, and profitability, some may be better, much will be the same, and quite a bit may be worse.

XXII. TRENDS IN FREIGHT TRANSPORTATION: 1975 to 2000

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XXII. TRENDS IN FREIGHT TRANSPORTATION: 1975 to 2000

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Introduction

Transportation of freight in the year 2000 will not be very different from today.

The next 25 years will be evolutionary. Quantities to be moved will increase moderately. Characteristics of shipments will gradually change. Technological innovations will be less significant than in the 25 years just passed. Institutional and operating changes will probably be of greater importance. Freight and passenger transport operations will continue to be mostly separate, with interrelationships limited to small portions of total movements.

Demand

Volumes of freight will increase, but substantially less than often predicted. Lengths of hauls will shift; some products and commodities will move shorter average distances, others longer ones.

Many analysts forecast much larger freight volumes. Such predictions are extensions of present trends, to which are added additional growth of some commodities. Increases of population and gross national product, technological changes, and rising standards of living are all interpreted as adding to the amounts of freight to be moved.

Population growth will indeed continue; demographic characteristics make that certain. Population may stabilize after 2000, but this cannot happen before. Other characteristics affecting demand for freight transport are less predictable. Standards of living may well decline. Income redistribution between groups of our population will probably continue. Life styles are changing. Spacial arrangements of communities will change. Product characteristics are changing too. These and many other factors will increase the quantities of some of the kinds of freight to be moved, and decrease other kinds.

Several examples may stimulate thoughts about many others.

Bulk Commodities. Coal movements may increase signficantly. The big unknown is how much electric power consumption will increase. Certainly less oil and gas will be used in generating stations. But what will be the relationships between nuclear, coal, and solar fuels? Earlier optimism about nuclear plants, which need little transportation

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once they are operational, is decreasing. Coal requires, under some circumstances, a lot of transport. Solar energy needs none; this source may become significant well before 2000. Use of coal for making electricity will certainly increase. Some large tonnages will be moved over long distances, like from Utah to California, or from Montana to Tennessee. However, coal does not have to be moved to power plants; power plants can be located near the coal. Technology of long-distance power transmission improves steadily. More importantly, institutional restraints on power plant siting may change. Power companies usually locate generating plants within their service territories. But, does a Texas utility have to bring Wyoming coal to Texas? It could erect its power plant in Wyoming, and transport the electricity to Texas by wire. These are important considerations for forecasting volumes and patterns of railroad movements, and the alternative of coal-slurry pipeline developments as well.

Iron ores and other minerals are other heavy bulk products. Their movement volumes and patterns are established by the locations of mines, smelters, mills, and markets and are influenced by the demands of end users. A few large companies dominate each industry. Their logistics arrangements are well established, and there are no indications of needs for these to change substantially.

Petroleum movements will change somewhat. Smaller cars will burn less gasoline; electric cars would burn none. Domestic production moves along different routes than imports. Alaskan oil will cause redistributing of many other flows from fields to markets. Long-distance moves will continue to be by pipelines, deep-draft tankers, and shallow-draft barges. Highways, and rail in certain special movements, will be used for local distribution.

Construction materials, like lumber, cement, steel, and all sorts of other components, are related in the demand for their movements upon the extent and characteristics of construction operations. These are in turn dependent upon many factors, like social priorities, financial constraints, personal incomes, corporate profits, and governmental programs. They are related to building designs and perceptions about how much space people need. Similarly, construction of public works is variable, depending upon alternative uses of capital. Characteristics of the transportation of these commodities should not change too much. Rail is now significant for long hauls. Much of the movement is by truck because of the flexibility of delivery from plants and mills to construction sites. For example, a lot of lumber is trucked from Oregon to Southern California because the total logistics cost is less, even though the rail freight-rate may appear competitive.

Growing of bulk agricultural products, like corn and wheat, will increase. Worldwide demand is increasing, and agricultural production is now governmentally encouraged instead of being regulated, as in the past. Trucks and trains and barges and ships will continue to move these products in ways not too different from the best practices today.

Manufactured Items. Many products may change in size, weight, quantity, and distance to be moved. Consider, for example, how smaller automobiles produced in smaller quantities, in fewer locations, will affect the transport of a large array of commodities--such as steel, plastics, rubber, parts and subassemblies, finished cars, and so forth. More home vegetable gardening may mean less transport of canned, frozen, and fresh foods. Smaller houses and more apartment living have all sorts of implications for consumption of home furnishings, recreational equipment, and other products. What will continue is the fact that a multitude of varied products moving from many factories through many distribution channels to many consumers implies continuation of a highway-transport dominant distribution system. Rail and some water transport will be important for some but not all longer moves, and for certain specialized situations. Shippers today are willing to pay far more for truck than for rail services because their total logistics costs are less. This should continue to be true.

Logistics. An understanding of the logistics concept, or total distribution system approach, makes it clear that the price charged the shipper by the transportation company is not the dominant factor in choice of mode or service. Large amounts of freight move by highway rather than by rail, often at higher rates, because other factors are more important to achieving lowest overall distribution costs and acceptable service qualities. And, for many movements, trucking, and particularly private carriage, may indeed be the low-cost mode. The premium price for air freight service is paid for many, many items, because there are advantages compared to highway, rail, or water movements.

Technology

Freight transport technology will not be significantly different from now. Refinements of many details will continue. Measured in physical terms, both new capital investments and maintenance of existing equipment and facilities may decline below recent levels. The current degradation of rail facilities and services in the Northeast may be a foretaste of similar developments in other geographic areas, and for other modes.

Technical changes from 1950 to 1975 were much more extensive than what will happen from 1975 to 2000.

This period just passed saw the construction of most of the Interstate Highway System; the dieselization of the railroads; containerization of break-bulk shipping; development of supertankers and specialized bulk-cargo ships; deepening of harbor channels; perfection of coal-slurry pipelines; much larger inland waterway tows; increased mileages, depths, and lock capacities of inland waterways; and many other improvements.

There is no reason to expect equal changes in the next quarter century. There are no pressing needs for improvements in the technology of freight transportation. Other opportunities for increasing productivity, service quality, and profitability are much more significant. Most of them are more related to operational and institutional changes, than to possible changes in physical plant and equipment for transportation. Most importantly, society may have altered priorities, and one of them may be that improving freight transportation is not all that important, compared to alternative uses for time, money, energy, and toil.

Specific attention to the freight carrying modes follows.

Highway. This is the general-purpose freight (and passenger) transportation mode. It is the first choice for moving most products between most places. All other modes are specialized. They do some things extremely well, and are used, sometimes on a large scale, for specific reasons. But the motor truck is the almost universal freight carrier and will continue to play this role. Ever continuing fuel-cost increases will affect all modes, but highway more than rail or water. However, as already noted, the reasons shippers use highway transportation are not all that sensitive to the comparative costs or prices.

As for highways, the new-construction era is over. Funding the last 6,000 miles of the 42,500-mile Interstate System will last into the mid-1980s or even to 1990. Many of these miles may never be built. Monies for other roads and streets are becoming scarcer, as society's perceptions about highways change. It may well be that maintenance of what we already have, with selected capacity increases and safety improvements, will be the main activity.

Trucks may change some, but this will be more because of regulatory than technological motivations. The biggest desires of motor carrier operators are for increases in dimensions and weights. Allowing an 8'6" rather than 8'0" maximum width would result in an 8'0" interior dimension. Note that urban buses not operating on federal aid highways are now often 8'6" in width, making wider aisles and seats possible. Increased lengths and so-called triple-bottoms, or three tailing units, on major highways are desired. These already operate in some states, and also in some countries in Europe, but are not permitted by many other states, including Pennsylvania, which is a geographic bottleneck in interstate trucking. A new law allows heavier axle loadings on Interstate highways; the motor carriers are working to keep those increases.

As for equipment design, a major change for large trucks will be increased use of turbine engines. Some are already operating, and freight carriers are said to like them. Similarly, the largest intercity passenger bus operator favors them in its new buses. The difficulty is that the principal manufacturer of such engines is expanding production very slowly. Fuel efficiency can be improved by using fiberglass

aerodynamic fairings fastened to the front of the first trailer in tractor-trailer rigs; this decreases wind resistance. Several manufacturers are selling them now.

Rail. Freight transportation is the basic activity of American railroads, with a few exceptions such as commuter services and passenger operations in the Northeast Corridor. Many people visualize this in reverse, seeing railroads in terms of passenger transportation, and are largely unaware of their freight-carrying roles. Viewing them as freight carriers helps to clarify technological forecasting for the railroads.

Evolutionary refinements are the forecast for the future. Major innovations in technology are not likely, though many opportunities exist for improving present physical facilities. The big opportunities will be in operational and institutional changes.

Track will not change very much. Continuous welded rail on treated wood ties is the preferred track design for heavy-weight, high-speed, high-impact freight trains. Current experiments with and limited installations of concrete ties and slab track will not encourage major installations in the foreseeable future. Bridges and tunnels will not change much. Signalling and control technology is evolving in parallel with other electronics, but the need for fail-safe high reliability in all climatic and operating conditions will continue to demand conservative design. Recent difficulties with automation of passenger transportation installations like the Bay Area Rapid Transit System and the many troubles of the automated coal-carrying Black Mesa and Lake Powell Railroad, are not going to hasten similar innovations and changes in conventional freight railroading. Communications will evolve with the state-of-the-art in general. Use of computers will continue to increase, but most major applications will be further refinements of what is already happening on some properties. Automatic car identification is in trouble at least in part because its use is not that rewarding; computers and video equipment offer other ways of keeping track of car locations.

Rolling stock design will evolve gradually. Specialization of freight cars will continue to increase as advantages from a total logistics standpoint outweigh the increased empty return miles. Covered hopper cars for grain, automobile rack-and-parts cars, and special cars for chemicals are examples. Locomotive designs will evolve from the best currently operating diesel-electric and all-electric units. Easy maintainability is the biggest desire expressed by railroad managements. Couplings for freight cars may change, but the large required investment promises only modest returns and delays implementation. Surprisingly, AMTRAK's new Metroliner-type cars have conventional couplings, even though these will operate in segregated services. Truck designs will gradually improve. Other gradual changes will take place. Most freight cars being built today will still be operating 25 years hence.

Recent research on track-train dynamics will result in many modifications to car components and dimensions, but more importantly to train makeup and operations.

What will the major changes be?

Containers and trailers of flat cars (COFC/TOFC) will continue to evolve and develop. They are not the answer for all freight; specialized freight cars are more suitable for many commodities and movements, and conventional freight cars will continue to have a role. They have their place, within limits of operating complexity, labor costs, regulatory constraints, institutional problems, and the like; and the percentage of merchandise freight moving by rail in trailers and containers will gradually increase.

Railroad electrifications on a large scale will start when the financial and institutional barriers are taken care of; by the year 2000, many more miles of track will be under the wires. Barriers include the large amounts of money needed, problems about priorities of routes to electrify, the role of the U.S. government as a participant, and the laws restricting electric power companies to specific service territories. Nothing is still needed in the way of technical innovation. Everything required already exists in major operating installations, in Europe and North America. Catenaries carrying 25 kilovolt and 50 kilovolt, 60 Hertz power pose no problems, other than requiring modification of signal circuits. The two major U.S. manufacturers of locomotives are already turning out high horsepower electric locomotives.

Air. Air freight, in weight, volume, value, and revenue, will continue to expand. Whether it will be profitable to carriers is less predictable. The logistics concept makes it clear that for many products and markets the premium paid for moving freight by air is returned by lower overall physical distribution costs, and improved service to customers. There are, in addition, many commodities that it is practical to move only by air; fresh flowers across oceans are one example.

What is important at this point is the future of technology in relation to use of this mode for freight. Several factors are relevant. The volume is growing, and as it does, the price differential in comparison to other modes can become less. While most air freight moves in passenger airplanes, and many of the operating costs are thus shared with the passengers, a significant and expanding amount moves in aircraft dedicated to this service. Airlines are still buying all-cargo versions of the largest commercial airplane, the 747F, which can move more than 100 tons (equal to the weight-carrying capacity of one large railroad freight car and the volume of several of them) over intercontinental distances, and they are offering new services with them.

An attractive variety of passenger and freight carrying aircraft, of all sizes and service characteristics, are avilable now from airplane

manufacturers; these range from the large widebody jets down to twin-engine transports.

The major issue here is whether a market exists for new airplanes for all-cargo, or mixed cargo-passenger, services. Forecasting demand for equipment is more difficult than for other modes. It is obvious that a new large airplane can only be produced at enormous preproduction cost and the break-even point for profitability only comes after delivery of way over 100, and often several hundred, aircraft. The financial traumas caused by the L-1011 will not soon be forgotten. Even the armed forces, often the financial supporters and major customers for new aircraft designs, are finding money more difficult to get, and their priorities may be directed toward procurement of other kinds of equipment.

New, more efficient airfoils, quieter engines, better fuel efficiency, and other innovations make the concept of designing and building a new airplane attractive. On the other hand, there are large fleets of existing airplanes, and the advantages of the new ones compared to them are marginal. This is not like the improvements of the new jet-powered over the older piston-powered aircraft, in the replacement cycle of 10 to 15 years ago. Large improvements in subsonic speeds are impossible. Larger lifts may bring some lowering of costs per ton-mile, but the costs of aircraft operations are only a part of the total costs of operating an airline. Thus, marginal savings are not that significant compared to the risks of large new capital investments. In an industry with low profitability, with several important airlines in deep financial trouble, the time is not propitious for selling new kinds of airplanes to them.

Thus, it is quite possible that the next 25 years may see the introduction of no new aircraft important for air freight services. It may be that effort will be concentrated upon refining and improving existing types. Aircraft manufacturing will then have become similar to highway truck or railroad locomotive manufacturing. This is to serve a market of replacing worn-out equipment, providing maintenance and upgrading parts, and providing for some growth, but not offering a product that makes all existing equipment obsolete, as happened with the propeller to jet, or the steam to diesel-electric, changeover. A different world indeed for aviation!

Water. Two different kinds of transport service are waterborne. These are services provided by large ships operating in deep water, and those by shallow draft barges in inland waterways. Though both operate in water, they differ as much as highway and rail do as land modes.

In both cases the technology is well advanced and requires no significant improvements.

For deep-draft vessels, increased speed requires much larger increases in fuel comsumption. Thus, especially with energy costs increasing,

practical limits are imposed on voyage times. Size contributes to productivity, but the large bulk carriers, tankers, and containerships are at practical size maxima now. For general cargo, container ships are now the standard on major trade routes. Automation and advanced propulsion machinery have reduced crew sizes to the minimum acceptable to labor organization. There is a glut of ships of all types on the high seas. Charter rates are at unremuneratively low levels (owners may lose less money when their ship is operating than when it is idle) and many ships are tied up. Rate wars are prevalent for the merchandise trades. Ships have become enormously expensive to build and buy, as well as to operate. Not an encouraging setting for growth and change!

Proposals for surface-effect ships for ocean commerce move forward slowly. Developing this technology would require large amounts of money, in the face of major operating unknowns, and at the cost of high fuel consumption per revenue ton-mile. The resulting services would fall between fast containerships and air freight in transit time. It may be that the market for this in-between service is small.

Inland or shallow-draft water carriers have as their business the moving of bulk products, like grains, ores, coal, petroleum products, and sand and gravel. These move in large quantities, up and down major rivers that have been canalized. Equipment and operating patterns are well established. Groups of standardized barges are lashed together into large rafts, called tows. Dimensions of tows are determined by channel widths, including passing requirements, and by dimensions of navigation locks. These are pushed by towboats, most of them large diesel-engine propelled vessels, almost all built in recent years. If the very large cost to general society of building and maintaining the waterways is treated as a free good, which is current governmental policy, then the cost of providing inland waterway transportation is the vessel operating cost, and this is pleasantly low for shippers of bulk products. In effect, inland waterways make possible private and contract carriage of large quantities of bulk commodities, which is not practical or cost-effective by highway, and not possible by railroads, which operate only as for-hire carriers charging published rates.

Pipelines. Oil and gas pipeline technology is evolutionary. Larger diameters, operated over long distances in difficult climates (like the trans-Alaska project) pose many challenges, but they are all elaborations of already existing industry practices. Solids pipelines are at earlier stages of development. A coal-slurry pipeline has been operating for several years in Arizona. Many other airlines are proposed.

A major problem is not technical; it is one of water supply. For example, a recently proposed line from Wyoming to the Southeast was dropped from consideration because Wyoming officials objected, not to the mining of the coal, but to the export of the water. Proposals for moving grain, potash, iron ore, and other commodities by pipeline are made from time to time, but have not gone beyond small experimental installations.

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What is significant is not so much the technical details, but rather the competitive aspects. New movements of coal and other commodities are important to railroad companies, whose lines mostly operate well under capacity. If a pipeline is built, that traffic is permanently lost to the rail mode. In addition, the potential exists for substantial shifting of present bulk traffic from existing railroads to new pipelines. Only the unwillingness of the State of Pennsylvania to grant eminent domain rights for right-of-way acquisition, thus protecting its railroad companies, appeared to prevent major coal pipeline construction across the State in the mid-1960s.

Operational and Institutional Changes

Some transportation operations will change significantly, largely as a result of institutional factors. There will be institutional changes, because there have to be. For example, it appears almost certain that in the next 25 years the ownership patterns of U.S. railroad facilities and enterprises will change significantly, and this will fundamentally affect operations. Sufficient capital will not be available from either private or public sources to do what might be desirable, particularly as regards investments in new plant and equipment. Society may deliberately reduce the percentage of available resources and the dollar amount of investment in transportation, as it is already doing in highway construction and passenger aircraft procurement. Other issues and activities will probably be seen by society to have higher priorities. The characteristic of relatively low profitability of the total freight transportation system will continue. Individual enterprises with superior managements, favorable geographic settings, or particularly desirable clienteles or commodity flows will prosper, even within modes that are unfavorable in an overall sense, just as now. Direct governmental involvement, through ownership and operation, will increase well beyond today's significant levels. This will be particularly true for railroads, but to some extent for each of the modes. Private enterprise will continue to be dominant in equipment and operations, with government increasingly dominant in providing fixed plant and significant in operating control systems, as well as continuing to regulate economics, safety, and operations. Regulatory constraints on price and service competition may be a little less than today, though this will not necessarily result in improved transportation services, or enhanced profitability. Refinements in technology and operations will continue to occur, motivated by safety and environmental considerations, and by compelling needs to reduce costs and increase efficiencies.

Energy

Energy price, availability, and possible rationing problems will inhibit major changes in characteristics and technology of freight transport services. For example, development and production of passenger-oriented, high-performance aircraft like V/STOLs and SSTs or high-speed ground

transport like TACVs and MAGLEVs, all of which have high energy consumption, will be slowed or stopped. Similar changes in freight transportation that require higher energy consumption will also not occur.

On the other hand, it must be recognized that energy costs will still be only a small part of total operating costs. For example, doubling or even tripling of fuel prices will increase total costs of operating freight transport modes by 10% to 20%. If prices charged by transport companies increase proportionally more than those of other sectors of the economy, because of the high energy consumption of transportation, then use, at least growth in use, may decline. Some shifts in market shares of a few percentage points as between modes will occur, but these will be minor, as the uses of each mode for moving freight have evolved to what they are today for compelling reasons. Some shifts may be very significant, and range from lucrative to fatal for individual carriers, but they do not presage fundamental shifts in transport technology or services.

Innovation

Where will innovation in freight transportation occur, between now and the year 2000?

Probably, it will not be in major technological changes. Numerous improvements will take place, but these will be incremental rather than fundamental. The physical plant and equipment in the year 2000 will not be substantially different, and most of the fixed plant and much of the equipment being constructed and manufactured today will still be in service.

Institutional changes, as already noted, will occur, allowing some rationalization of the railroad network, and freeing all modes from some of the current regulatory restrictions imposed on them. These will make some more price and service competition possible.

Operating changes offer major opportunities for innovation. This is especially true for the rail mode. New concepts of dynamic real-time scheduling of freight cars and trains are now possible by using computers. Combined with changes in agreed rules about freight cars moving over more than one railroad company, and operating more city-pair and yard-pair freight train services, service quality and cost performance will improve.

Work rule changes will offer opportunities for doing many things differently from now, and yield higher productivity. Some modes have relatively few such restrictions, other have many. Such changes cannot be imposed; they must be negotiated. This requires initiative and imagination on both sides, along with a willingness to share the rewards. It is often tedious to accomplish.

Marketing changes, particularly orienting transport services to fit ever more appropriately into total customer logistics systems, are probably the prime opportunity for continuing innovation.

Summary

All in all, transportation of freight in the year 2000 will not be all that different from today. In service, quality, price, and profitability some may be better, much will be the same, and quite a bit may be worse.

XXIII. ENERGY CONSIDERATIONS IN GOODS TRANSPORTATION

by

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ABSTRACT

There is need for a definitive study of U.S. goods transportation. The changes induced by altered residence patterns, industrial locations, and technologies have been accommodated only by straining the transportation system. The energy crisis, the Eastern railroad crisis, and the sharp increase in distribution costs should provide incentives for a critical examination of the goods transportation and distribution systems needed in the 1980s and beyond.

Existing technology will allow significant improvement in performance and service of railroads and allow a better modal distribution. The greatest obstacles to change are the institutions of transportation: regulatory agencies, trade unions, highway lobbies, railroad companies, and highly concentrated industries.

Several methods exist for the reduction of energy utilization in a distribution system. In a decade, a 30% improvement in vehicle energy efficiency could be obtained. Government intervention to encourage higher vehicle utilization and intermodal transfer is perhaps the most promising means. Railroads, trucks, and air fleets are all operating at significantly below capacity levels, in part because of geographical and seasonal patterns, vehicle specialization, and restrictions imposed by the regulatory agencies. A small reduction in service standards may have a very large energy conservation payoff. Because of the demand for high service standards, there is a tendency to use energy-inefficient modes (e.g., trucks, instead of rail for movements in excess of 750 miles).

Perhaps the greatest gains in energy-cost effectiveness can be obtained by reducing the ton-miles of freight demand. Geographical concentration of industry is too high for both distribution and energy efficiency in many industries.

The existing distribution patterns and the widespread use of energy-inefficient modes are, to a large extent, the result of careful cost analysis by users, bad price setting by carriers, and the inability of institutionalized transportation agencies to meet changes in population distribution, product mix, and service expectations. Now that energy costs are high and energy availability presents problems, companies must reexamine their distribution plans.

The logistic demands of goods distribution systems are influenced by many factors, some of which can, in turn, be influenced by government policy, expressed in regulation, subsidy, taxes, government spending, resource allocation, and the pricing of public services. The factors include population and income distributions, absolute and comparative advantage, economies of scale in production and marketing, total cost of transportation, and resource and industrial concentrations.

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Any analysis of goods transportation must consider the total cost (or cost per unit) of a logistic system, rather than transportation costs alone, and the total energy consumption from plant to customer, rather than only the energy consumed by transportation vehicles in moving from plant to warehouse. In an era of abundant and low-cost energy supplies, small inventories and short lead times have been used as indicators of efficient distribution systems. Changes in distribution systems, forced by the energy shortage, can serve to reduce the cost of distribution.

Models capable of reducing system costs can be developed by classifying user systems in terms of magnitude (weight or measurement tons), coverage (national, regional), product characteristics (density, fragility, etc.), and product type.

A "what if" model of distribution system operation and performance is preferred in that it allows the user to examine the national behavior of carriers and shippers to policy action scenarios, and it allows the policymaker to estimate the effects of policy changes in terms of energy consumption, costs, and system throughput and performance.

XXIII. ENERGY CONSIDERATIONS IN GOODS TRANSPORTATION

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XXIII. ENERGY CONSIDERATIONS IN GOODS TRANSPORTATION

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Introduction

There is need for a definitive study of goods transportation in the United States. The changes induced by altered residence patterns, industrial locations, and technologies have been accommodated only by straining the transportation system. The energy crisis, the Eastern railroad crisis, and the sharp increase in the cost of distribution should provide incentives for a critical examination of the goods transportation and distribution systems needed in the 1980s and beyond.

The changes in population distribution and the increasing transportation demand have been met by three decades of massive highway investment and minor modifications in the rail system. Many changes in the post-World War II decade now appear to have been shortsighted (e.g., the removal of tracks on the San Francisco-Oakland Bay Bridge in 1958, the demise of the trolley network in Los Angeles to accommodate cars). The inability of railroad management and the Interstate Commerce Commission (ICC) to recognize the role of reliability in distribution and transportation has contributed to a railroad crisis which only strengthens the energy-inefficient (for long distances) trucking industry. For example, ten years ago some major railroads refused to consider unit-train services for containerized freight, giving as one of the reasons that it would "destroy the existing rate structure."

The problems of freight transportation are predominantly institutional problems. Existing technology will allow significant improvement in performance and service of railroads and allow a better modal distribution. No major technological innovations will affect goods transportation in the next decade. Significant changes in systems operations and materials handling (within the scope of existing technology) will be introduced and/or expanded. The rate of change will depend on government policy (in terms of financial incentives and regulatory actions) and the pressures imposed by energy shortages. The greatest obstacles to change are the institutions of transportation--regulatory agencies, trade unions, highway lobbies, railroad companies, and highly concentrated industries.

The balance of the paper will deal with the following interrelated topics: The need for, and ways of, reducing energy inefficiencies in goods distribution systems in view of the current energy crisis; present patterns of goods distribution; factors affecting logistic demands of goods distribution systems; the need for evaluating total costs in a logistic goods system; elements for a proposed goods distribution model and related systems performance measurements; and the need for a goods distribution system model.

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Methods of Reducing Energy Inefficiencies in Goods Distribution Systems

Goods distribution systems are related to the locations of population centers, production centers, and the existing investments in a transportation infrastructure. The current interest in energy forces a reevaluation of these systems, particularly their distribution patterns.

The energy used in a distribution system can be reduced by:

1. Improvements in the energy efficiency of vehicles
2. Improvements in the efficiency of the use of vehicles
3. Transferring freight carriage to the more energy-efficient transportation modes
4. Reducing the ton-miles of freight carriage demand
5. Reducing the service standards of the distribution system

The several methods are not completely independent, nor do they have equal effects. There are physical limitations on the extent to which vehicle efficiency can be extended; and given the size of existing vehicles, the transition to an overall increase of 30% in vehicle efficiency will require a decade.

Much can be accomplished in a shorter time by increasing the efficiency of the use of vehicles. This would no doubt affect service standards. At the present time 43% of rail car-miles are empty car-miles; even for box car and trailer-on-flat-car service, 32% of car-miles are "empty." If one considers light loads and empty miles, perhaps as much as half of the rail-miles are empty. While the figures for trucks are somewhat better, the cargo-miles lost in empty backhauls represent a significant portion of intercity cargo capacity. Similarly, well over half of the belly cargo capacity of the U.S. air fleet is unused.

While part of these losses are due to geographical and seasonal patterns and to vehicle specialization, restrictions imposed by regulatory agencies contribute to the wastage of capacity and, in turn, energy. If the role of the regulatory agencies is to serve the nation as a whole rather than their own constituencies, then we already have a structure to change transportation and distribution patterns; but it may well be better to disband the agencies (or at least coalesce them) and use taxes and incentives to change the patterns. Since the regulatory agencies are prime candidates for change, the political problems of change may not be too difficult to overcome at this time. This suggests that government intervention to encourage higher vehicle utilization and intermodal transfer is the most promising means of increasing the energy-cost effectiveness of goods distribution systems. Given existing knowledge of inventory analysis, it is anticipated that these measures would

result in an increase of perhaps 20% in working inventories to compensate for the decline in service standards for the same levels of production.

Because of the demand for high service standards, there is a tendency to use energy-inefficient modes (e.g., truck instead of rail for movements in excess of 750 miles). The railroads have begun to respond, particularly with trailer-on-flat-car (TOFC) and container-on-flat-car (COFC) express services, but they have only recaptured part of their lost markets. A small reduction in service standards may have a very large energy conservation payoff.

Perhaps the greatest gains, in terms of energy-cost effectiveness, can be obtained by reducing the ton-miles of freight demand. Geographical concentration of industry is too high for both distribution and energy efficiency in many industries (e.g., brewing, clothing, breakfast foods, some parts of the chemical industry, etc.). In short, many distribution systems are too concentrated for energy efficiency.

In the short run, the largest gains in energy-cost effectiveness can be obtained by suitable mode transfers and increasing vehicle efficiency (at the cost of a loss in service standards). Over the medium term, efforts should be made to reduce the ton-mile demand by dispersing industries which can be economically efficient at a smaller scale. Thus we may once again hope to find, for example, breweries in Little Rock and Harrisburg.

Work should also continue on new and/or more efficient internal combustion engines, as well as on other means of propulsion. Of all means of reducing energy consumption, this requires the most time and money. The other alternatives may be more difficult in political and social terms.

Present Patterns of Goods Distribution

Previous studies of the problems of goods distribution have centered on the transportation network and the ways in which it is used. It would be more appropriate to concentrate on the demands imposed on the network and the ways in which demands can be met. The energy and environmental crises--and the other major problems of the transportation industry--indicate that one can no longer look to patchwork solutions for meeting logistic needs.

The existing distribution patterns and the widespread use of energy-inefficient modes are, to a large extent, the result of careful cost analysis by users, bad price setting by carriers (and perhaps by regulatory agencies), and the inability of institutionalized transportation agencies to meet changes in population distribution, product mix, and service expectations. We "enjoy" the highest standard of distribution service level of any country, but we pay a high price (in energy consumption and in cost) for that standard. Approximately 9% of the gross

national product goes to pay our freight bill; warehousing, inventory, and other items more than double our distribution bill.

Distribution systems of major companies were finely tuned to transportation and storage and handling costs and geared to meet the distribution of demands. Energy costs were a very small component of the total cost. Now that energy costs are high and energy availability presents problems, companies must reexamine their distribution plans. All analytic methods for the distribution of consumer goods under the previous energy situation yielded solutions that placed distribution centers located in or near the 15 or 20 major population centers. For low-valued goods produced over fairly wide regions, handling centers at key railroads were used to coalesce shipments (e.g., lumber).

The energy crunch suggests that the optimal solutions will change and result in a doubling of the number of distribution warehouses; empty warehouses in Spokane, Des Moines, Little Rock, Charleston, and perhaps Syracuse may be full in the 1980 to 1985 period. This would be a reversal of the trends of 1965 to 1975, and it would reduce the growth rate of air cargo tonnage. The effect on truck and rail market shares is uncertain.

In terms of transportation energy demands, the large urban center is more efficient than a suburban center. (It is probably more efficient in terms of total energy consumption as well.) The energy crisis in the period 1974 to 1985 will lead to a revival of the center city. An influx of middle-class residents has begun in a number of cities (San Francisco and Philadelphia, for example). The movement will probably be stronger at first in cities of less than 500,000. Population increases in center cities will provide large enough markets for some industries which are now highly concentrated to relocate. This would reduce the demand for intercity transportation, reduce, of course, the number of multiple-car families if the urban centers had adequate mass transportation (buses and light rail vehicles); and reduce the mileage by private cars.

Up to now, government policy has inadvertently (or purposely) favored suburbia (e.g., FHA loan policies, highway grants, aid to commuter railroads) over the cities (except, perhaps, for social welfare programs). A reversal of their policies and additional tax incentives can accelerate the revival of the city. The political problems associated with the changes are significant if not overwhelming. The changes may well come without political action, but at a slower rate.

Factors Affecting Logistic Demands of Goods Distribution Systems

The logistic demands of goods distribution systems are influenced by many factors, some of which in turn, can be influenced by government policy expressed in regulation, subsidy, taxes, government spending,

resource allocation, and the pricing of public services. The factors include:

Population distribution

Income distribution

Absolute and comparative advantage

Economies of scale in production

Economies of scale in marketing

Total cost of distribution

Resource concentration

Industrial concentration

Population and income factors are important because they indicate centers of demand, particularly for consumer products. Absolute and comparative advantage, along with total transportation cost, determines the market area for a commodity or product. Absolute advantage may refer to natural or geographic features (for example, the concentration of fruit and produce in California, wood products in the Northwest) or to historical or technological conditions (for example, automobiles and parts in Detroit, breakfast foods in Michigan). Economies of scale in production limit the number of sources for a product (for example, electric light bulbs in Nela Park), economies of scale in marketing limit the number of sources even when optimum production size has already been achieved (for example, brewing, breakfast foods).

On the basis of distribution costs and service standards of 1970, large production and marketing companies such as Del Monte and General Electric (consumer products) have reduced the number of distribution centers for national marketing to fewer than 20. Until now, energy consumption has not been a consideration in logistic planning nor in the choice of modes into and out of the distribution centers.

For point-to-point movement of a fully loaded vehicle, energy consumption per ton-mile can be determined in a relatively straightforward manner (though recently published figures should be treated with caution if not skepticism). Unfortunately, the transportation involved in distribution systems is not usually point-to-point by a single mode. Often the movements require indirect routings and empty legs. Further, the commodities are not uniform in transportation density and the several modes use energy sources of different thermal content, form, efficiency, price, and availability. And finally, distribution system alternatives usually involve varying capital and labor factors.

Another indication of the extent of the omission of energy considerations in distribution system planning is that neither industry nor government has a good measure of the effect of a fuel cutback on system performance. Further, there is no model that will allow industry or government to evaluate the effects on energy consumption of technological changes in energy use (for example, improved carburetion) or in rolling stock (for example, a national 70-foot highway-trailer length unit).

The Need for Total Costs Evaluation in a Logistic Goods System

In planning a distribution system, the planner must consider the size and location of market centers, the costs of transportation to and from warehouses by mode, the cost of holding and transshipping inventory, the lead time and the standard deviation of lead time by mode, and the standard of service expected by the customer.

Any analysis of goods transportation must consider the total cost (or cost per unit) of a logistic system, rather than transportation cost alone. Similarly, it should consider the total energy consumption from plant to customer rather than only the energy consumed by the transportation vehicles in moving from plant to warehouse. Eventually, all costs are met by the consumer and all energy needs are drawn from the national stock. Therefore, any analysis of national logistics should include consideration of the throughput, location and market areas of distribution points, and both the loaded and backhaul movements of vehicles in the various modes. It should also consider, for example, the role of intercoastal; coastwise and inland waterway shipping, where applicable; and the proposed airfreight network.

In an era of abundant and low-cost energy supplies, small inventories and short lead times have been used, sometimes erroneously, as indicators of efficient distribution systems. With higher energy costs compounded by increasing scarcity, the indicators should be changed. The rate of such change can be influenced by government policies as well as by economic realities. A one-time increase in in-transit inventory or safety stock may be a small price to pay for a greater degree of energy independence.

In developing distribution systems, there has been an overemphasis on time efficiency and an underemphasis on energy efficiency. A recent review of modal selection in goods transportation indicates that the resource allocations in existing distribution networks is, in fact, cost inefficient--even when the costs of safety stocks and in-transit inventories are included. Thus, it would appear that changes in distribution systems, forced by the energy shortage, can serve to reduce the cost of distribution.

Elements for a Proposed Goods Distribution Model and Related Systems Performance Measurements

The alternatives available to specific shippers and consignees are generally limited. The choice made in both the long and short run can be influenced by government policy either fiscal, regulatory, or subsidy. It is essential that a technical and economic data base and evaluation procedures be developed to assist policymakers.

Consideration should be given to such a study. At the very least, the needs for analysis and evaluation should be defined. The following are some views on factors that should be included: demand patterns, reordering procedures, lead times, inventory levels, warehousing locations, frequency and size (unit loads, less than unit loads, multiunit loads) of shipments and regional and interregional markets of the company and the industry. The analysis must also recognize the type of cargo movement (bulk, neobulk, unitized, and specialized freight) in order to compare alternative modes of transportation and alternative methods of storage.

It seems that models capable of reducing system costs can be developed by classifying user systems in terms of magnitude (weight or measurement tons), coverage (national, regional), product characteristics (density, fragility, etc.), and product type. The following product-type classifications are suggested:

1. Bulk industrial (coal, ore, heavy chemicals, etc.)
2. Bulk agricultural
3. Industrial products
4. Consumer products (nonfood)
5. Consumer products (processed food)
6. Special handling (fresh produce, heavy equipment)

All of the above factors have an impact on modal choice and they, in turn, are influenced by changes in modal performance. Any combination of reduced frequency and decreased speed will increase transportation lead times and require an increase in inventory levels if the same distribution service standard is to be maintained. If the changes in frequency and speed reduce transportation costs (and energy consumption), the resulting increase in inventory may well be justified on economic grounds. Transportation and distribution planning is very much a game of trade-offs. The introduction of new energy constraints tends to sharpen the analysis of trade-offs.

The trade-off potential should be analyzed in terms of measures of physical distribution system performance. These measures include the following:

Transportation cost per ton-mile

Inventory-to-sales ratio

Total distribution cost per unit

Variance of lead time

Frequency of stock-cuts (or emergency replenishment)

Determination of just what measures, and what degree of detail, are critical. The possible variations are virtually limitless--but the study would have a strictly limited time frame and resource allocation. Since the study goal would be to go beyond the use of national averages, some degree of detail is essential.

The basic criteria for what elements must be measured are directly related to the goal of obtaining estimates of the effect on shipping patterns--and thus on fuel consumption--of various potential governmental influences. To this end, it would be necessary, at a minimum, to measure the effect of:

1. Transportation service type (for example, rail TOFC, truck LTL/PTL) as a determinant of elapsed time, operating cost characteristics, and equipment utilization.

2. Transportation freight equipment type (for example, rail 50-foot plain boxcar, truck 45-foot van trailer) as a determinant of certain critical operating and capital cost elements, vehicle capacity and weight, and aerodynamic and rolling resistance characteristics.

3. Transportation motive power equipment (for example, rail 3000-HP two-axle tractor) as a determinant of fuel consumption levels, load capacity, capital costs, and aerodynamic and rolling resistance characteristics.

4. Right-of-way characteristics (for example, grade and curvature), as major determinants of fuel consumption, load capacity, and elapsed time.

5. Average operating speed, as a major determinant of fuel consumption, and as a potential contributing factor to elapsed-time capabilities.

6. Typical operating patterns (for example, intermediate terminal incidents and delays, crew size, and work day) as determinants

of critical time and cost elements, even within a given service type.

7. Technology level (for example, existing equipment mix, minor streamlining and efficiency improvements, major redesign within limits of developed technology) as a prime determinant of achievable transportation efficiencies.

It is, of course, neither necessary nor desirable that those concerned with the formulation of national policy should trouble themselves with details of the type outlined above. But unless they are taken into account in some phase of the proposed analysis, the study results will be no better than if national averages were used.

A "what if" model is preferred because it allows the user to examine the national behavior of carriers and shippers to scenarios which result from policy actions. In a similar way, it allows the policymaker to estimate the effects of policy changes in terms of energy consumption, costs, and system throughput and performance.

Flexibility is essential if the model is to meet the requirements of policymakers. Given the pressures for technological and operational innovation, energy efficiencies and vehicle productivities cannot be expected to remain at present values. In fact, energy and fiscal policy can affect these values directly. Similarly, the distribution of population or of industrial activity cannot be expected to remain the same over the next 10 to 20 years. The model should be able to treat scenarios that include the revival of the central city or a pattern of exurban and rural production centers, as well as new technologies of production, transportation, or consumption.

Conclusion

The operating and energy inefficiencies of existing goods transportation networks can be overcome without requiring extension of the state-of-the-art in any mode. The obstacles to improvement are institutional, not technical. To understand the problems of distribution and transportation, we need better economic and energy models. With these, we can evaluate the trade-offs between service, cost, energy consumption, and investment and use the results of the analysis to influence institutional changes.